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SOUTH ALTOONA FOUNDRIES.

PENNSYLVANIA RAILROAD.

The wheel and grey iron foundries of the Pennsylvania Railroad were formerly located at Altoona in connection with the locomotive repair department. They were old and not equipped with modern facilities, were entirely too small and the space occupied by them was badly needed for the extension of the locomotive repair department. A comparatively small proportion of the output of the foundries is used by this department at Altoona, and the amount of material received and shipped to other parts of the system, by the foundries, is so great as to make it advisable to have them entirely separated from other departments and located so that good shipping facilities are afforded to all parts of the system. To increase the output and to operate with greater economy it was necessary to build an entirely new plant. As foundry work is purely a manufacturing proposition, and as the combined foundries were of such magnitude as to require a separate department, it was decided to remove them to South Altoona, about two miles from the Altoona shops. It is proposed, as far as possible, to concentrate the foundry work for the entire system at this point.

This new plant, at present, consists of a wheel foundry, grey iron foundry, machine shop and material building, pattern shop, power house and a handsome two-story brick, 40x60 ft., office building. It is located on a plot of ground 5,500 ft. long and of an average width of 900 ft., extending alongside the single-track Hollidaysburg branch, which connects Altoona to the low grade freight line, extending between Galitzin and Huntingdon, at Hollidaysburg. This plot is large enough to provide, if necessary, for a generous extension of the present foundries and also for the future addition of brass and cast-steel foundries. The details of the design and operation of the plant were carefully worked out by the railroad company, and it is undoubtedly the most complete plant of its kind in this country.

WHEEL FOUNDRY.

The wheel foundry has a capacity of 900 wheels per day, which is greater than that of any other wheel foundry under one roof in this country. It is a steel frame brick building. The interior is a single room 600 ft. long and 186 ft. wide, with no divisions between the moulding floors, annealing pits and cleaning rooms, but with a space 60x410 ft. enclosed for the cupola, sand storage, core and wash rooms. These rooms have brick partitions. The long side of the building is divided into thirteen 46-ft. bays; each bay has nine roof trusses, spaced 23 ft. apart. The trusses are independent of the walls and partitions and are supported by steel columns arranged in fourteen longitudinal and nine transverse rows. The side walls are composed very largely of glass, and the monitors, which extend across each section of the building, have skylights their entire length, so that the day-lighting is excellent. The monitors are wide and high and equipped with swinging sash, thus affording splendid ventilation.

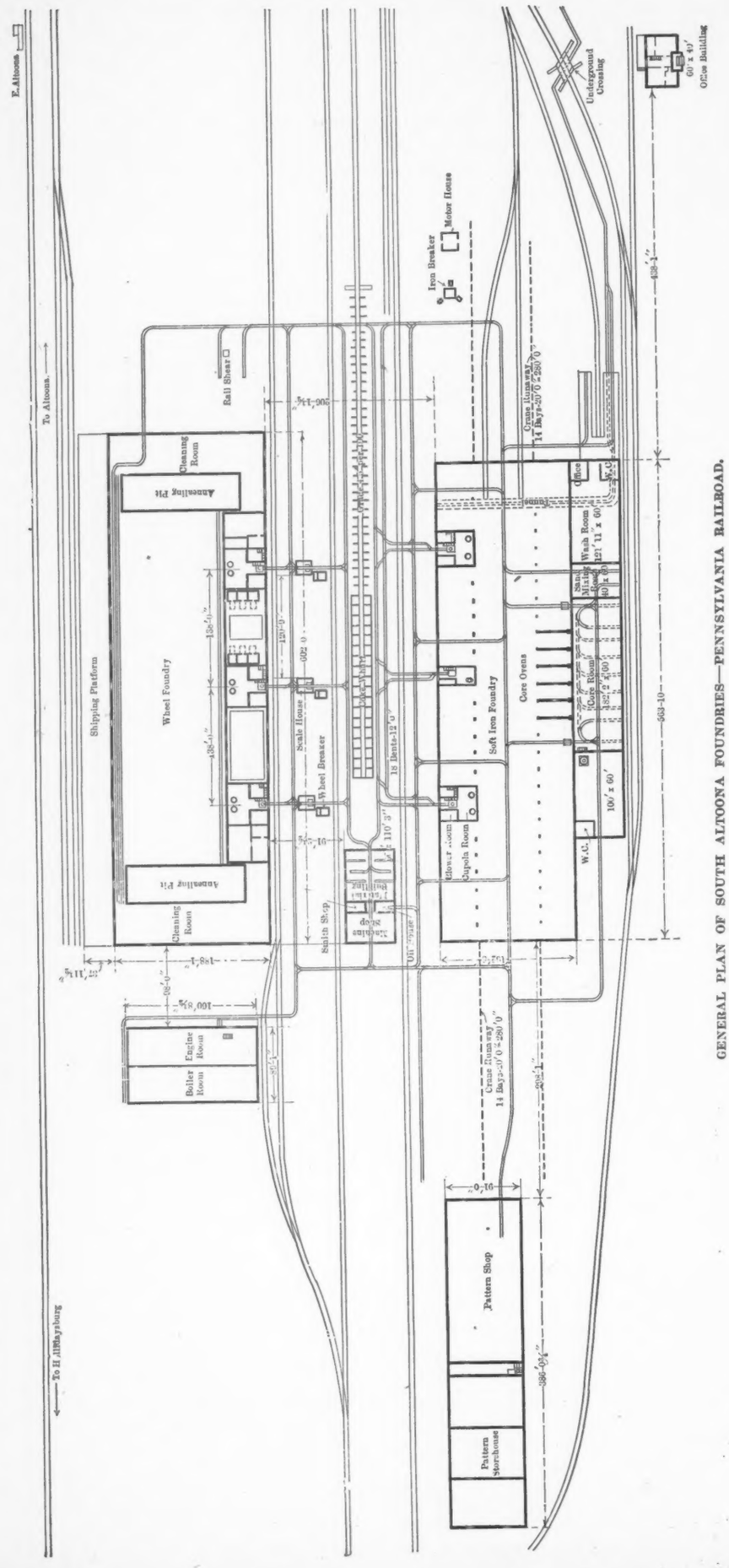
Referring to the floor plan of the building it will be seen that the arrangement is symmetrical about the centre transverse axis. With the exception of the cleaning rooms and annealing pits at each end of the foundry, it is, however, made up of three complete divisions, each consisting of a pair of 86-in. Paxson-Colliau type cupolas and twelve 25-wheel moulding floors, each served by an independent trolley or hoist, but all dependent upon a system of longitudinal cable cars for the delivery of the molten iron and for the removal of the wheels to the annealing pits at each end of the moulding floor. Each of these three divisions is practically independent of the others.

The compact and efficient working of the wheel foundry can probably be best understood by following the course of the raw material from the storage yard until it reaches the shipping platform in the shape of a finished wheel. Referring to the general plan of the plant it will be seen that the storage space between the wheel and grey iron foundries, and adjacent to the former, is divided into three sections corresponding to the divisions of the wheel foundry. The supplies are delivered on the standard gauge tracks and are distributed throughout the plant by small cars on the narrow gauge tracks. Coal and coke are unloaded by gravity from hopper-bottom cars into the bins underneath the long trestle.

Small flat cars are loaded by hand with the required class of pig-iron, are then pushed on the scale in the weighing room, where the proper amount of broken car wheels is added to make up a load of 2 tons. The car is then pushed on to the platform of the hydraulic plunger elevator, 5 tons capacity, in the cupola room, and is raised to the charging floor, pushed alongside one of the two cupolas and its contents charged by hand. Each of the cupolas has a capacity of 12 tons per hour.

Near each scale house is a wheel breaker where old wheels are broken by a 1,700-lb. hammer falling 19 ft. on a concave anvil block imbedded in the ground. The weight is raised by hydraulic power. The breaker is enclosed in a steel frame structure 8 ft. 6 ins. by 15 ft. The outside covering is corrugated iron laid on white pine. On the inside there is a 2-in. oak lining 13 ft. high and this is covered with ¼-in. steel plate for a height of 8 ft.

Two of the cupolas are provided with Sturtevant No. 10 blowers driven by 60 h.p. motors, and the other four are provided with 55-in. Sirrocco blowers furnished by Davidson & Company, Belfast, Ireland, and driven by 60 h.p. Westinghouse motors. Each blower is enclosed in a small room.



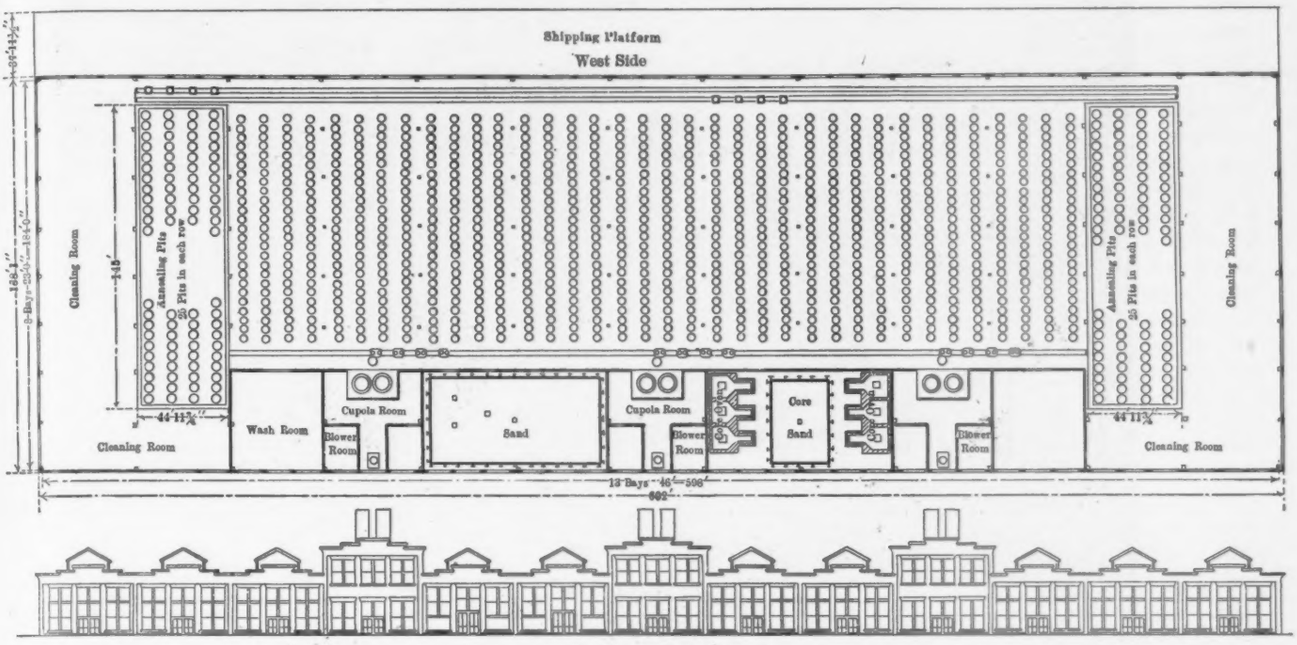
GENERAL PLAN OF SOUTH ALTOONA FOUNDRIES—PENNSYLVANIA RAILROAD.

The core room is located between two of the cupola rooms and is equipped with two sets of three ovens; a coke furnace underneath each oven is fired from a pit under the core room floor, and has two flues which deliver the gases to the rear corners of the oven, where they rise, pass up through the shelves at the back to the top and then return to the floor and to the outlet at the lower front corner. In the centre of each oven is a vertical shaft with collars which support seven shelves of 3/16-in. perforated tank steel 10 ft. 6 ins. in diameter and spaced 13⅛ ins. apart. The shelves are mounted on ball bearings and revolve independently. Between the two sets of ovens is a 40x28x10-ft. (550-ton) sand bin with wooden walls 2½ ins. thick, supported by an outside steel frame work of 12-in. I beams.

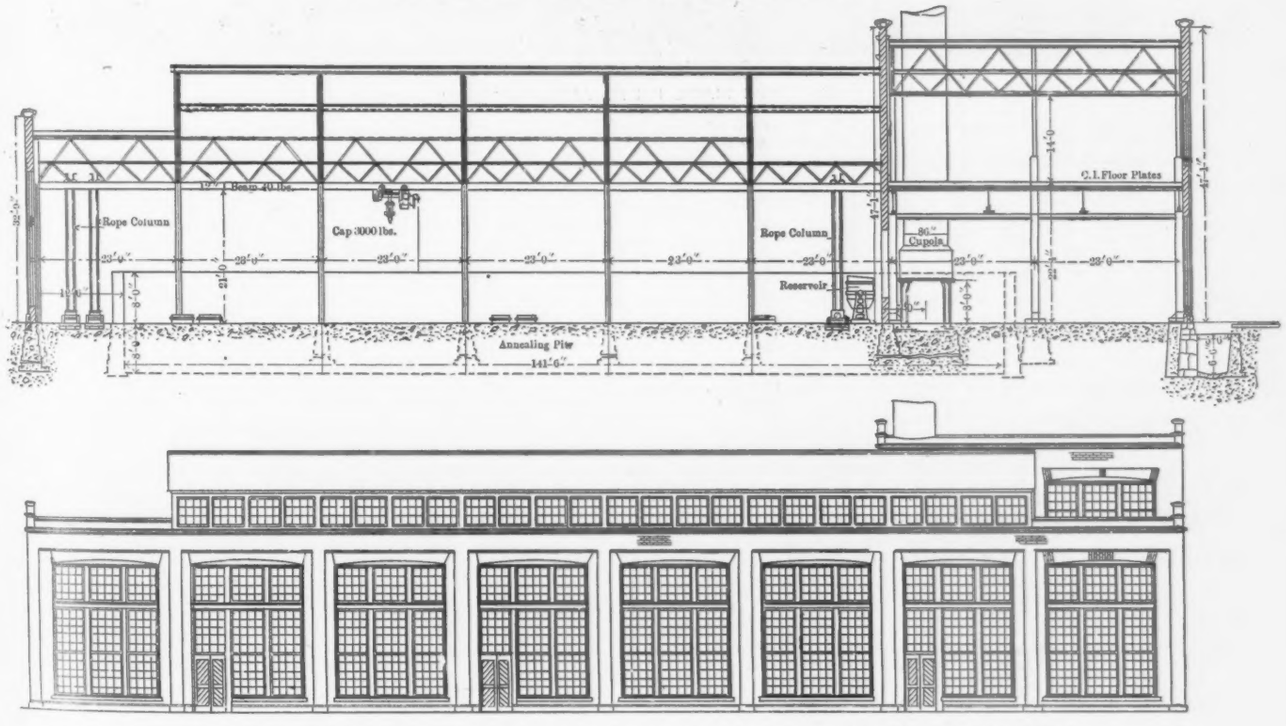
The sand for the moulders' use is stored in a 40-ft. 9-in. x 82-ft. 3-in x 12-ft. (1,840-ton) bin. The sand is sifted by an electrically driven machine manufactured by the Fairbanks Company, Springfield, Ohio, and is delivered to the moulding floor in wheelbarrows.

Each bay in the foundry proper covers one unit of four moulders' floors, each of which is 11 ft. wide, extending across the foundry, and has on the centre line a pair of rails 24 ins. apart, upon which 25 flasks are set. There are thirty-six of these rows, which give a maximum capacity of 900 wheels per day, assuming that one is obtained from each flask. Over each row of moulds is a specially designed Sprague electric trolley hoist. These hoists run on 12-in. I beam tracks, and both the hoisting and traversing operations are controlled by one handle, which can be reached from the floor, and is so arranged that if desired both operations may be carried on at the same time. They have several hoisting speeds, ranging from 16 to 75 ft. per minute, and a range of traversing speeds up to 400 ft. per minute. The nominal capacity is a lift of 1,000 lbs. at 60 ft. per minute. The tracks for these hoists extend beyond the line of flasks and over the narrow gauge tracks at each end of the moulding floor.

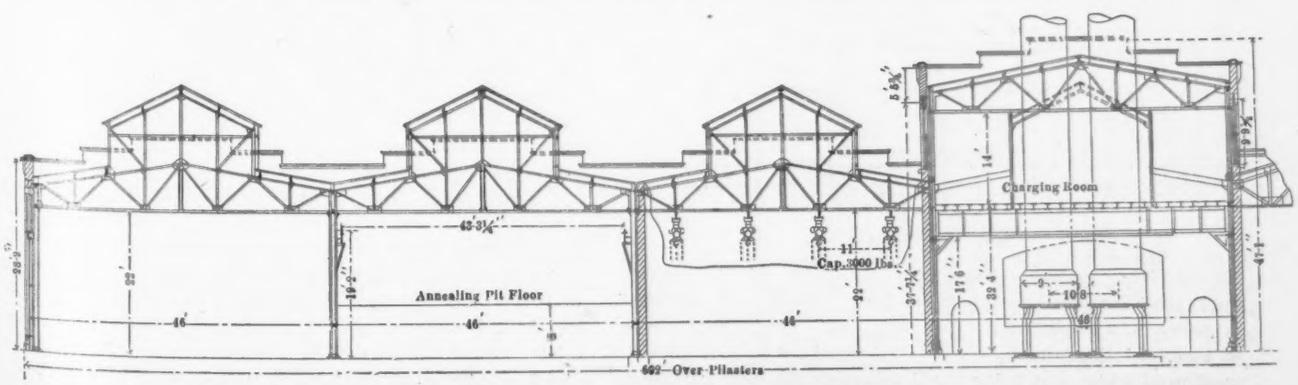
Each pair of cupolas discharges into a reservoir of 14,000 lbs. capacity, consisting of a brick-lined steel shell mounted on trunnions. These reservoirs are tilted by a chain which passes over a sheave on the end of the trunnion shaft and is operated by an hydraulic cylinder located underneath the bed-plate and controlled by a valve conveniently placed. In front of each of these reservoirs is a narrow gauge track upon which four small ladle cars coupled together are operated by a cable driven by a reversi-



PLAN AND SIDE ELEVATION OF WHEEL FOUNDRY.

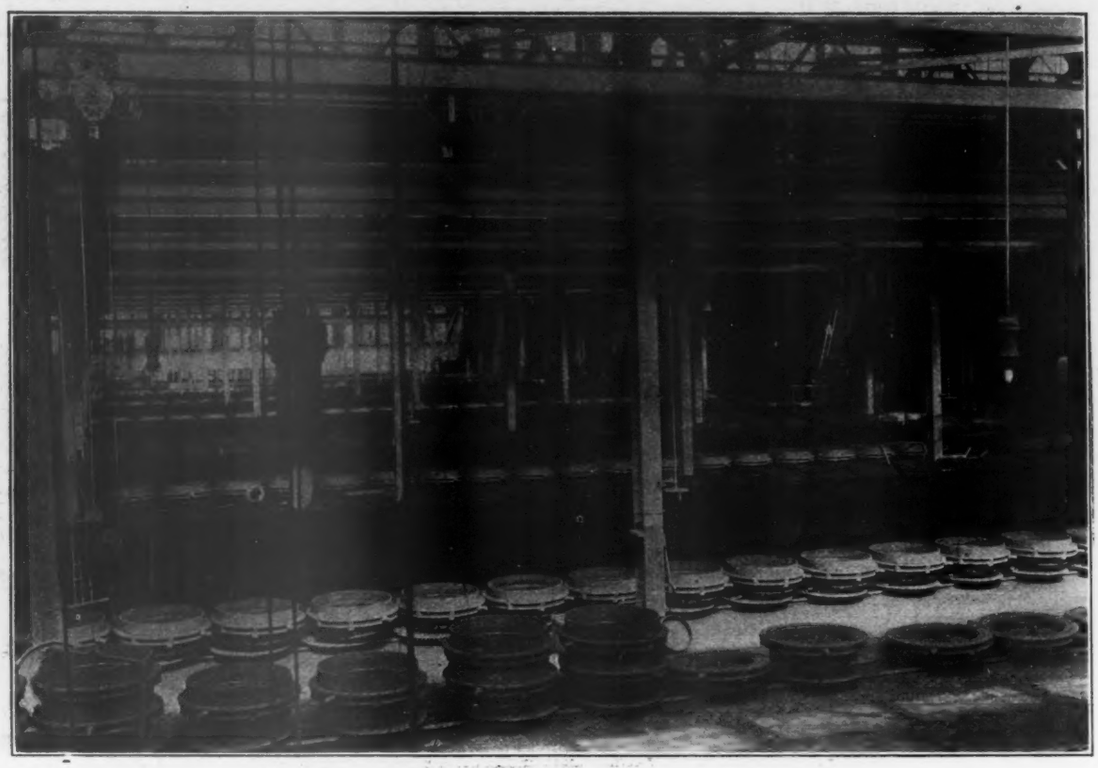


END VIEW AND TRANSVERSE SECTION THROUGH THE MOULDING FLOOR AND CUPOLA ROOM.

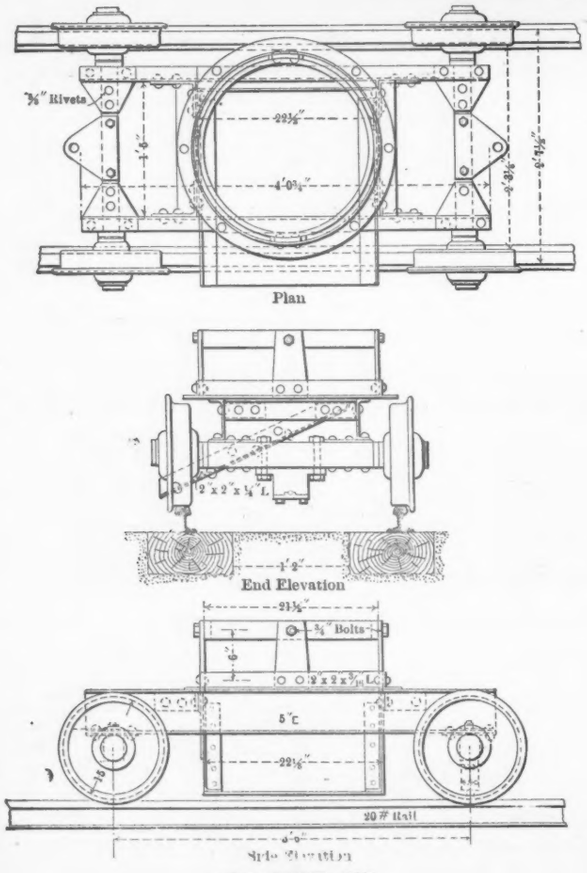


PART LONGITUDINAL SECTION AT ONE END OF FOUNDRY.

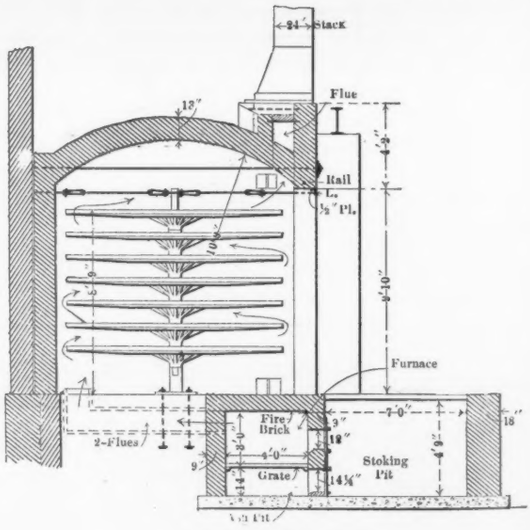
WHEEL FOUNDRY, SOUTH ALTOONA—PENNSYLVANIA RAILROAD.



MOULDING FLOOR, SOUTH ALTOONA WHEEL FOUNDRY.



HOT WHEEL CAR.



CORE OVEN.

ble electric motor. Each car consists of a shallow steel shell or box mounted on four wheels and designed to carry a 1,000-lb. ladle on each end. The reservoir is so arranged that the flow from the cupola does not have to be stopped while it is being tilted to supply the pouring ladles. As soon as the pouring ladles, each of 1,000-lbs. capacity, on the four cars, have been filled, they are run opposite the set of four rows of moulds which are to be poured off.

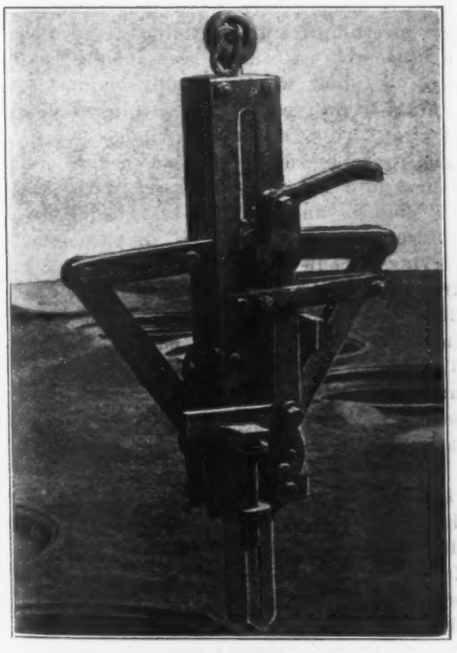
The cars are spaced the same distance apart as the rows of moulds, and the ladles therefore stop directly under the four hoists. As soon as the ladles have been removed the cars are moved to another set of moulds, where they pick up the empty ladles which they had previously delivered and return to the reservoir. As each train of cars takes care of three units of four moulding floors, they are in continual operation during the process of pouring off.

On the opposite side of the foundry from the cupolas are two duplicate haulage systems parallel to each other and close together, upon which the cars which deliver the wheels from the moulding floors to the annealing pits are operated. Two trains of four cars each, spaced 11 ft., centre to centre, operate on each track. As soon as the flasks have been uncovered the wheels are removed and placed on the cars by the trolley hoists. The four cars are loaded at the same time. The wheel is laid on an angle iron ring supported at four points from the framing of the car and having an inclined platform or chute under it, so that the sand can fall freely through the ring and frame and be delivered by gravity to the floor

outside of the track and in a convenient position to be removed without interfering with the operation of the trains. The trains are operated by a controller located in a cage near the annealing pits and high enough above the floor to furnish a good view for the full length of the track.

VIEW OF THE WHEEL FOUNDRY SHOWING STORAGE PLATFORM.

The two annealing pits, 41x140 ft., have an inside depth of about 17 ft. The masonry retaining walls, which enclose each side of the pits, rise about 8 ft. above the foundry floor. The bottom of the pit is covered with 6 ins. of concrete, sloping toward one corner, for drainage. Four rows of 25-sheet steel brick-lined cylinders, 40 ins. inside diameter and 16 ft. high, each having a capacity of 25 wheels, are supported on concrete platforms or benches 18 ins. above the bottom of the pit, and spaced 11 ft., centre to centre. The tanks are made of ⅜-in. steel, are lined with 6 ins. of fire brick and are spaced about 18 ins. apart. The space between the platforms is filled with coarse broken stone, between the tanks is a layer

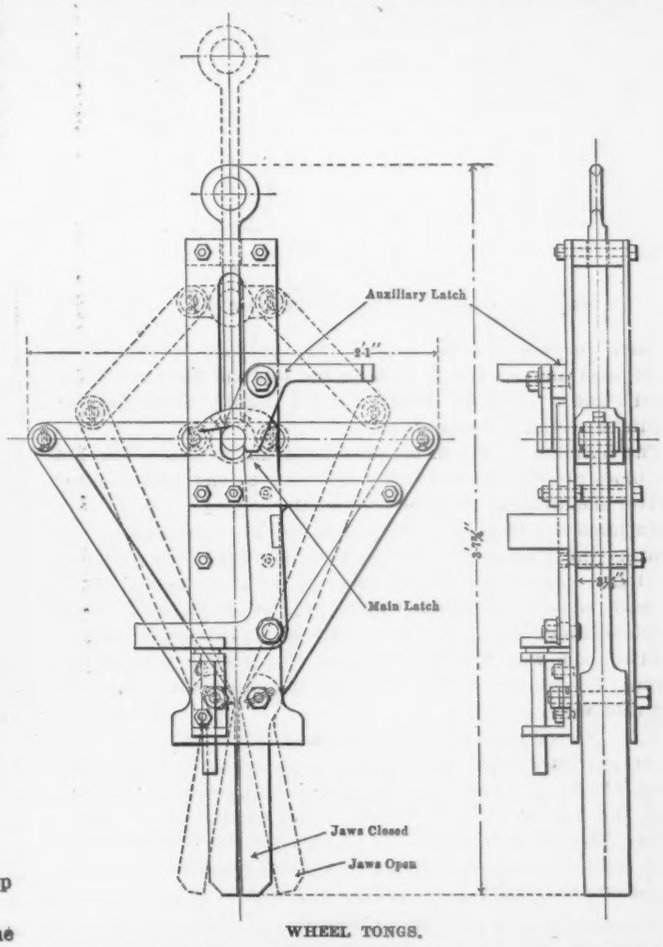


WHEEL TONGS.

of fine stone, and above this green and burnt sand to the top of the walls.

Extending over each annealing pit is a traveling crane having a span of 44 ft. and a capacity of 4,000 lbs. This crane has four independent hoists, spaced 11 ft. apart, each driven by a 7½ h.p. motor, controlled separately from the cab. The crane is operated by a 10 h.p. motor and traverses at a speed of 500 ft. per minute. The hoists operate at speeds up to 100 ft. per minute. There is a spare hoist on the bridge and an extra motor for traversing which can quickly be connected up in case the regular motors should get out of order.

The wheels from the moulding floor, which are delivered in sets of four, are removed by the four hoists and are placed in the annealing pits, the cars returning for another load. An ingenious and special design of tongs developed at Altoona is used for lifting the wheels from the cars and depositing them in the annealing pits or for removing them from the pits. These tongs consist of two bent links hinged near the bottom of the frame work, the lower end of the links or jaws extending below the frame. The upper ends of the links are joined by toggle links, and these toggle links are connected by a pin, which is guided by a slot in the frame work and one end of which projects beyond the side of the frame. A latch having a horizontal arm at the bottom and with a hook on the side of the vertical arm is hinged near the bottom of the frame work in such a position that the hook may extend over the pin at the toggle connection and thus hold the jaws closed. As the jaws are lowered into the cored hole in the wheel a vertical pin, which is carried in a guide and extends below the frame work, comes in contact with the hub of the wheel, forces the horizontal arm of the latch upward, thus

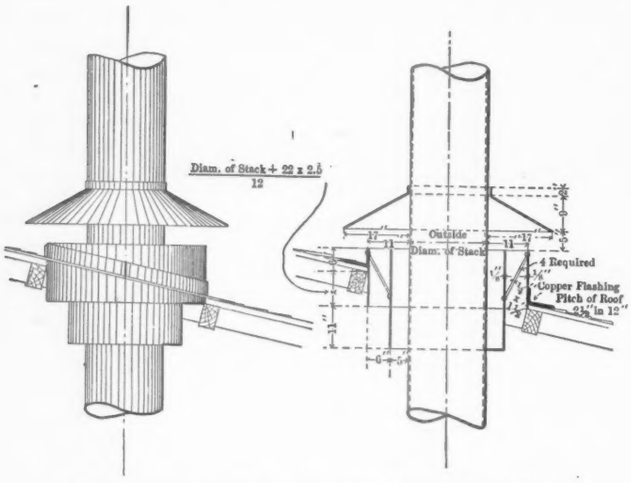


WHEEL TONGS.

throwing the hook which locks the toggle connection to the right. As the tongs are hoisted the lower jaws are forced outward and firmly grip the wheel. Near the top of the frame work is hinged an auxiliary latch with an extended arm, by which it may be thrown in or out of operation. Before lowering the wheel into the annealing pit this auxiliary latch is thrown over so that when the wheel strikes the bottom the toggle closes and the auxiliary latch engages the pin and prevents the tongs from again griping the wheel.

After remaining in the annealing pits five days the wheels are taken out and delivered to the cleaning floor at the opposite end of the pits from the track on which they are delivered, and after they have been cleaned, inspected and measured are rolled to the storage platform, which is on a level with the cleaning floor, is 38 ft. wide, extends along the full length of the foundry, and is 4 ft. above the top of the shipping track, so that the wheels can be rolled directly into the cars. This storage platform will hold about 5,000 wheels.

The method of carrying the stacks through the roofs of the foundry buildings in order to provide a generous air space around them and protect the roof from heat, and at the same time to keep out rain and snow, is a very ingenious one, and is illustrated in detail on the accompanying engravings. The dimension X is derived from the following formula: Diameter of the stack plus 22 times the pitch of the roof in 12 ins. divided by 12. The other dimensions shown are the same for different roof pitches and for all diameters of stacks except the very large ones. For very large diameter stacks, such as for the wheel foundry cupola, which are about 7 ft. 3 ins. in diameter where they pass through the roof, a thicker plate



METHOD OF CARRYING STACKS THROUGH THE ROOF.

is used for the circular bands, and they are reinforced by light steel angles riveted at both the top and bottom. Other details and dimensions are also varied slightly to furnish the requisite strength and stiffness.

The building is heated by the Sturtevant system. The hot air pipes are carried above the roof trusses and branch pipes deliver the air near the floor level at the columns.

Enclosed arc lights are hung close to the roof trusses. For lighting the storage platform and the storage yards, enclosed arc lights are hung from the exterior walls of the buildings. At each end of the foundry there is a 44x48 ft. wash room, which includes a dressing room with expanded metal lockers, a toilet room with porcelain fixtures, 50 porcelain washbasins, a row of 6 shower baths, which are supplied with both hot and cold water.

MACHINE SHOP AND MATERIAL BUILDING.

The machine shop and material building is of brick and about 60x100 ft. About one-third of it is used as a machine shop, the work consisting largely of the making of car wheel chills. The rest of the building is used for the storage of fire clay, fire brick and manganese, and small portions are partitioned off for a smith shop and an oil house.

(To be continued.)

TIRE TURNING.—I make it a rule and hope that I get those results in our shop, that there must be no full set of tires turned on any engine without one of those tires shows a witness mark. That is supposed to be the smallest tire of the set. By witness mark I mean that there must be a black spot, perhaps as large as your finger that the tool has not touched.—*Mr. A. E. Manchester, Western Railway Club.*

STANDARDIZING LOCOMOTIVE EQUIPMENT.

CANADIAN PACIFIC RAILWAY.

The locomotive equipment of the Canadian Pacific Railway, like that of all roads of similar age and size, consists of a miscellaneous and very varied collection of old, middle-aged and new power, and contains examples of practically every step in locomotive development from the time the road was first incorporated. This road has, however, for years past, kept in mind the advantages obtained from a proper standardization of as many parts of a locomotive as possible, even though the type of engine as a whole may vary, and in establishing a new and heavier series of engines which are designed to meet the demands of the present time, the motive power department of this road has carried out this principle by making as many locomotive parts as possible, interchangeable between such classes of locomotives as conditions of design, construction and operation would permit.

In undertaking the work it was clearly recognized that there was a limit beyond which standards would become as great an evil as their entire absence, and so a careful study of all affecting conditions was made in every case to determine just how far to carry the work. This resulted, in some cases, of a part being standard for only one or two classes and somewhat modified for others, and in other cases of it being standard for all engines. Taken as a whole, the standardization has been carried much farther than has been done heretofore, and some parts have been brought to a standard basis which have formerly been considered to be outside the practical range. The cylinders and valve motion are examples of this.

Another factor which also had a direct influence on the final result was the fact that it was advisable, as far as possible, without affecting their value for future work, to retain many old parts which had been satisfactory and could with a small change be made to serve on several different classes.

With these governing features in mind, a very complete set of standard locomotive parts have been adopted, which, while it is expected that they will be strictly maintained on new power for the next five years, are also interchangeable on a surprisingly large number of the older engines.

The locomotive equipment of this road consists of 1,075 locomotives divided into 47 different classes, each class having from 1 to 94 engines, and in many cases being divided into a number of sub-classes. It includes simple engines having cylinders varying from 15 by 24 ins. to 21 by 28 ins., and boiler pressures from 130 to 210 lbs. per sq. in. There are included 321 two-cylinder compound locomotives, which is probably a greater number than will be found on any railroad in this country. These have cylinders varying from 19 and 29 by 24 ins. to 22 and 35 by 30 ins.

In the use of superheaters this road occupies the position of being the pioneer, and also of having by far the largest number in operation of any American railroad. There are altogether 187 locomotives built and on order (see table herewith) equipped with superheaters, which include examples of practically every known design except the Pielock. There is one engine fitted with the Schmidt smokebox superheater; 32 with the Schmidt boiler tube type; 62 with the Cole type, 22 of which have the internal superheating tube and 40 the return bend. All of these designs were illustrated and thoroughly described in Mr. Vaughan's paper on superheating read before the last convention of the Master Mechanics' Association. There are also 92 locomotives fitted with the Vaughan-Horsey superheater (AMERICAN ENGINEER, February, 1906, page 41). In every case of both compound and superheater engines there are simple fire tube engines in the same class with which comparisons of operation can be made.

A system of per cent. rating for locomotives is in use on this road which is based on tractive power, a 100 per cent engine being one with 20,000 lbs. tractive effort, and the others being rated from that basis. This rating is used by both the operating department for dispatching and the motive power

department in its record of locomotive repairs and shop output.

On this basis the motive power of the Canadian Pacific varies between locomotives of 50 and 180 per cent., and has a single example of a 225 per cent. engine; this, however, being a geared logging engine, is not considered part of the ordinary equipment. It includes all of the usual types of wheel arrangements, but with the 10-wheel and consolidation types largely predominating, the former including 433 engines

LOCOMOTIVES EQUIPPED WITH SUPERHEATERS.

No.	Type of engine.	Class.	Cylinders, Simple or Com.	Size.	Remarks.
1	4-6-0	D.2	Simple	18" x 24"	Schmidt smokebox, In ser.
1	4-6-0	D.6	2-cyl. cross compound	20" & 33 x 26	Schmidt firetube, In ser.
1	4-6-0	D.9	2-cyl. cross compound	22" & 35 x 30	Schmidt firetube, In ser.
1	4-6-0	E.2	Simple	19" x 24"	Cole firetube, In ser.
21	2-8-0	M.4	Simple	21" x 28"	Cole firetube, In ser.
20	2-8-0	M.4	Simple	21" x 28"	Schmidt firetube, In ser.
10	4-6-0	D.10	Simple	21" x 28"	Schmidt firetube, In ser.
30	4-6-0	D.10	Simple	21" x 28"	Cole firetube, In ser.
10	4-6-0	D.10	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
5	4-6-0	D.11	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
3	4-6-2	G.1	Simple	21" x 28"	Vaughan-Horsey, F. T., In ser.
3	4-6-2	G.2	Simple	21" x 28"	Vaughan-Horsey, under construction.
1	4-6-0	E.5	Simple	20" x 26"	Vaughan-Horsey, In ser.
50	4-6-0	D.10	Simple	21" x 28"	Vaughan-Horsey, under construction.
10	4-6-0	D.10	Simple	21" x 28"	Cole firetube, under construction.
*20	2-8-0	M.4	Simple	22½" x 28"	Vaughan-Horsey F. T., under construction.

*With these engines the boiler pressure will be 175 lbs., and cylinders have been enlarged in diameter to give the same power as similar engines having 200 lbs. boiler pressure and 21 x 28 cylinder.

of from 90 to 160 per cent. and the latter 230 engines from 100 to 180 per cent.

In undertaking under these conditions to make standards which will be of value for future power, it is easily understood that the smaller and older engines must be eliminated to a large extent, and in this case standard parts cover broadly but three types, the consolidation, the 10-wheel and the Pacific, as typified by classes M4, D10 and G1. Class D11 is the same as D10 with a different boiler, which is arranged for burning culm. Class D9 is an older class of 37 10-wheel freight engines, which was in operation before the work of standardizing

Class.	Type.	Cylinders	Dia. Drivers.	Per. Cent. Power.
M4	2-8-0	21 x 28	57	180
D10	4-6-0	21 x 28	63	155
D11	4-6-0	21 x 28	63	155
G1	4-6-2	21 x 28	75	140
G2	4-6-2	21 x 28	69	152

was undertaken, and with class M3, 42 compound consolidation, and class E5, 70 10-wheel passenger engines, has been followed in many respects in order to utilize as far as possible existing designs. Classes G1 and G2 are practically identical, except for size of drivers. On the five classes included the completeness of the work can be understood when it is stated that fully 60 per cent. of the parts are interchangeable.

The following will show clearly how broad a field has been covered by the standard parts and also the types of locomotives in each class. In the table, "X" is used to denote that the part is used on all classes marked. "Standard" denotes that the part is used with slight changes on all classes, and "Standard on all classes" denotes that the identical part is used on all classes:

	M4	D10	D11	G1	G2	No. of old engines using similar parts.
Axles, driving	X	X	X	X	X	162
Axles, engine truck	X	X	X	X	X	162
Axles, tender	X	X	X	X	X	211
Bell and ringer	STANDARD FOR ALL CLASSES.					
Fire box types (wide and radial stayed)	X	X	X	X	X	...
Fire box water space, F 5½, S 4½, B 3½	X	X		X	X	...
Boiler seams	STANDARD FOR ALL CLASSES.					
Crown stay, diameter	STANDARD FOR ALL CLASSES.					
Boxes, driving	X	X	X	X	X	143
Boxes, engine truck	X	X	X	X	X	105
Boxes, tender	X	X	X	X	X	211
Air reservoir, size	STANDARD					
Air pump bracket	STANDARD FOR ALL CLASSES.					
Brake shoes	STANDARD FOR ALL CLASSES.					
Bumper beams, knees and push boxes	X	X	X	X	X	114
Cab	X	X	X			All similar.
Cab ventilator	STANDARD FOR ALL CLASSES.					
Cab bracket	STANDARD FOR ALL CLASSES.					
Cab fittings throughout	STANDARD FOR ALL CLASSES.					
Cylinder cocks	STANDARD FOR ALL CLASSES.					
Crank pins			X	X	X	162
Cross Head and wrist pins	X	X	X	X	X	162
Cylinders	X	X	X			...
Cylinders G1 (same except saddle)				X	X	...
Cylinder head and casing	X	X	X	X	X	...
Cylinder vacuum & relief valves	X	X	X	X	X	...
Dome cap, ring and casing	X	X	X	X	X	...
Draw gear engine	X	X	X			...
Engine truck			X	X	X	...
Exhaust pipe and nozzle			X	X	X	...
Eccentric and strap	X	X	X	X	X	38
Fire door	X	X		X	X	...
Frame pedestal	X	X	X	X	X	...
Shoes and wedges	X	X	X	X	X	...
Frame foot plate	X	X	X			...
Frame foot plate				X	X	...
Expansion pad and knee	X	X	X			...
Guides		X	X			...
Guides				X	X	...
Grates frames	X	X		X	X	...
Grate bars	STANDARD.					
Hand rail and steps	X	X	X	X	X	...
Head light	STANDARD FOR ALL CLASSES.					
Cab lamps	STANDARD FOR ALL CLASSES.					
Number plate	STANDARD FOR ALL CLASSES.					
Gauges and small fixtures	STANDARD FOR ALL CLASSES.					
Injector	X	X	X	X	X	113
Injector pipes and valves	STANDARD.					
Boiler lagging	STANDARD.					
Cylinder and steam chest lagging	X	X	X	X	X	...
Link motion complete	X	X	X	X	X	Rad. of link changes.
Oil cups and lubricators	STANDARD FOR ALL CLASSES.					
Pilot	STANDARD.					
Pipe fittings	STANDARD.					
Pistons	X	X	X	X	X	4
Piston packing	STANDARD.					
Piston rods, material, steel	STANDARD.					
Wash out plugs	STANDARD FOR ALL CLASSES.					
Reverse lever	DUPLICATE IN PART.					
Reverse shaft	X	X	X	X	X	...
Reach rod (Length varies)	X	X	X	X	X	...
Rockers and boxes	X	X	X	X	X	...
Main rod, details	X	X	X	X	X	...
Slide rod, details	X	X	X	X	X	...
Knuckle pin	X	X	X	X	X	...
Sand box	STANDARD.					
Smoke box arrangement	STANDARD.					
Smoke stack daimeter		X	X	X	X	...
Springs	STANDARD.					
Spring rigging	STANDARD.					
Steam chest covers and casing	X	X	X	X	X	...
Safety valve	STANDARD.					
Steam pipes and T heads	M4e	D10c	X	X	X	...
V & H superheater T head	X	X	X	X	X	...
V & H superheater steam pipes, same except for set in G1&2	X	X	X	X	X	...
Tank valves, hose, strainer, etc.	STANDARD.					
Tender brake and rigging	STANDARD.					
Tender frame	STANDARD.					
Tender attachments	STANDARD.					
Tender tank	X	X	X			...
Tender tank				X	X	...
Tender tank filling hole and drain pipe	STANDARD FOR ALL CLASSES.					
Tender truck	STANDARD.					
Throttle			X	X	X	...
Dry pipe	X	X	X	X	X	115
Engine tools	STANDARD.					
Valve setting	X	X	X	X	X	...
Valve rod		X	X	X	X	...
Wheels and tires		X	X			...
Engine truck wheels and tires	X	X	X		X	82
Tender wheels and tires		X	X	X	X	...
Whistle and rigging	STANDARD.					

Boiler Circulation.—It is probable that in the wider fireboxes, the main mass of the fire being so much nearer the tube-plate, has a bad effect on the tubes, as the intensity of the temperature at the tube-plate must necessarily be much increased. The extra width of the box has enabled the tubes to be put much too near the sides of the barrel. When this is done, the water to feed up the spaces between the tubes near the back tube plate has to be drawn almost entirely from the front of the barrel, and it is possible that in some cases the space left for this purpose is inadequate. It will probably be found that neglect of this consideration is the cause of three-fourths of the tube trouble. There is no doubt that the upward draught of water through the spaces between the tubes for, say, 2 ft. from the back tube-plate, is very strong indeed, and in all probability this is enough to prevent the necessary feed of water down the spaces of the firebox unless ample area is given, so causing stay as well as tube trouble.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

DEPARTMENT OF TRANSPORTATION—McGILL UNIVERSITY.

Experience has shown that the great majority of university and college graduates know nothing of practical business ways and means when they leave college. This lack is particularly felt by the railroad officials, who have become suspicious of a system of education which omits from its curriculum the factors necessary to enable the student to apply his technical knowledge in the solving of practical questions.

With a view to correcting this unfortunate condition, McGill University, at Montreal, Canada, with the aid of the Canadian railways, has organized a department of transportation for those who intend to take up railway service as a profession, offering courses in the theory and practice of railways and in mechanical and civil engineering as specially adapted to railways.

The Canadian railways are backing the scheme and paying for it because they hope to get better men and more of them who are of the kind they can make leaders of. The department has been placed in charge of Mr. Clarence Morgan. The courses are designed for students who wish to enter the operating department or executive offices, the motive power department, or the engineering department, and as far as possible they will include active employment by the railways during the summer vacations.

The work of the first two years follows those of the other departments in the faculty of applied science, covering very thoroughly mathematics, physics, mechanical drawing, kinematics of machines, materials of construction and shop work. During the third and fourth year the students will specialize along the lines of the several courses. After graduation the students in the engineering courses will be expected to serve an apprenticeship of 2½ years on the railroad. It is hoped in this way to develop men who, by a thorough grounding in preliminary work, will be able to assume positions of responsibility within a reasonable time after graduation. The railroad will, of course, have the right to dispense with the services of any apprentice whose work or conduct is unsatisfactory. Neither do they agree to retain the men in their service after the completion of their apprenticeship. Work in these courses will be started in September of this year.

MARKING WHITE LINES ON BLUE PRINTS.—Add to a small bottle of water enough washing soda to make a clear white line, then add enough gum arabic to it to prevent spreading and making ragged lines. To make red lines dip the pen in red ink and then add a little of the solution by means of the quill.—*Ed. H. Remde, Machinery.*

50-TON STEEL UNDERFRAME GONDOLA CAR.

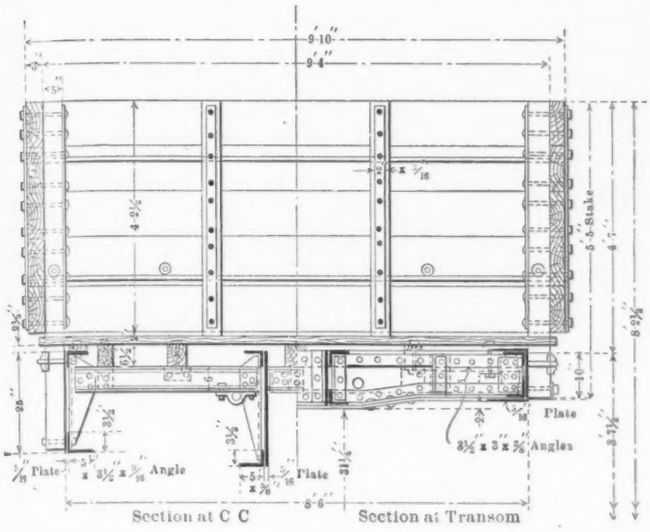
The Illinois Central Railroad has recently built at the Burnside shops 378 50-ton gondola cars with steel underframes furnished by the American Car & Foundry Company. These cars weigh 44,200 lbs. each and the inside dimensions are: Length, 41 ft. 9 ins.; width, 9 ft. 4 ins.; height, 4 ft. 2½ ins.

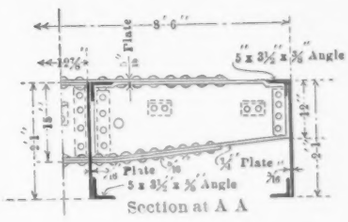
The centre sills between the bolsters consist of 5/16-in. steel plates with 5x3½x⅝-in. angles riveted at the top and bottom edge, as shown on the drawing. These sills are 25 ins. deep for a distance of about 10 ft. at the centre and taper to 12 ins. at the bolsters. The body bolster is built up of plates and angles and is continuous for the full width of the underframe. Two ⅜-in. plates spaced 6½ ins. apart have 3½x3x⅜-in. angles riveted at the top and bottom edges on the outside. These plates are 12 ins. deep at the centre and 10 ins. deep at the outer edge. Top and bottom cover plates, ¼ in. thick, stiffen the bolster and aid in securing it firmly to the sills. The web or plate member of the centre sills is attached to the bolster side-plate by two 5x3x⅜-in. angles, one on each side. The draft sills, 12-in. channels, 30 lbs. per foot, are attached to the body bolster in the same manner.

The side sills consist of a 5/16-in. steel plate with 5x3½x9/16-in. angles riveted at the top and bottom edges on the inside. These sills are practically of the same construction as the centre sills, but are continuous for the full length of the car. The ends of the bolster plates are attached to the side plates by the ⅜-in. U plate between the bolster plates and the 5x3x⅜-in. angles, as shown on the plan view. The end sills consist of ⅜-in. plate with 3x3x5½-in. angles riveted at both the top and bottom edges on the inside. The end sill plate is straight for a distance of 3 ft. 6 ins. at the centre of the car, and from this point slopes back 6 ins. to the corners. A ¼-in. plate, which is riveted to the top end sill angle, and also to the longitudinal sills, serves to stiffen the end of the car. The sills between the bolsters are tied together at frequent intervals by 6-in. channel plates, 10.5 lbs., near the centre of the car, and by 5-in., 9-lb., channels at other points. These are attached to the sills by angle plates, as shown. The stringers to which the floor planks are bolted are supported by these channels and are bolted to them. Two of the stiffeners, next to the two centre ones, consist of ¼-in. plate with flanges pressed at the top and bottom and tieing these stiffeners and the sills together are 5/16-in. top and bottom cover plates.

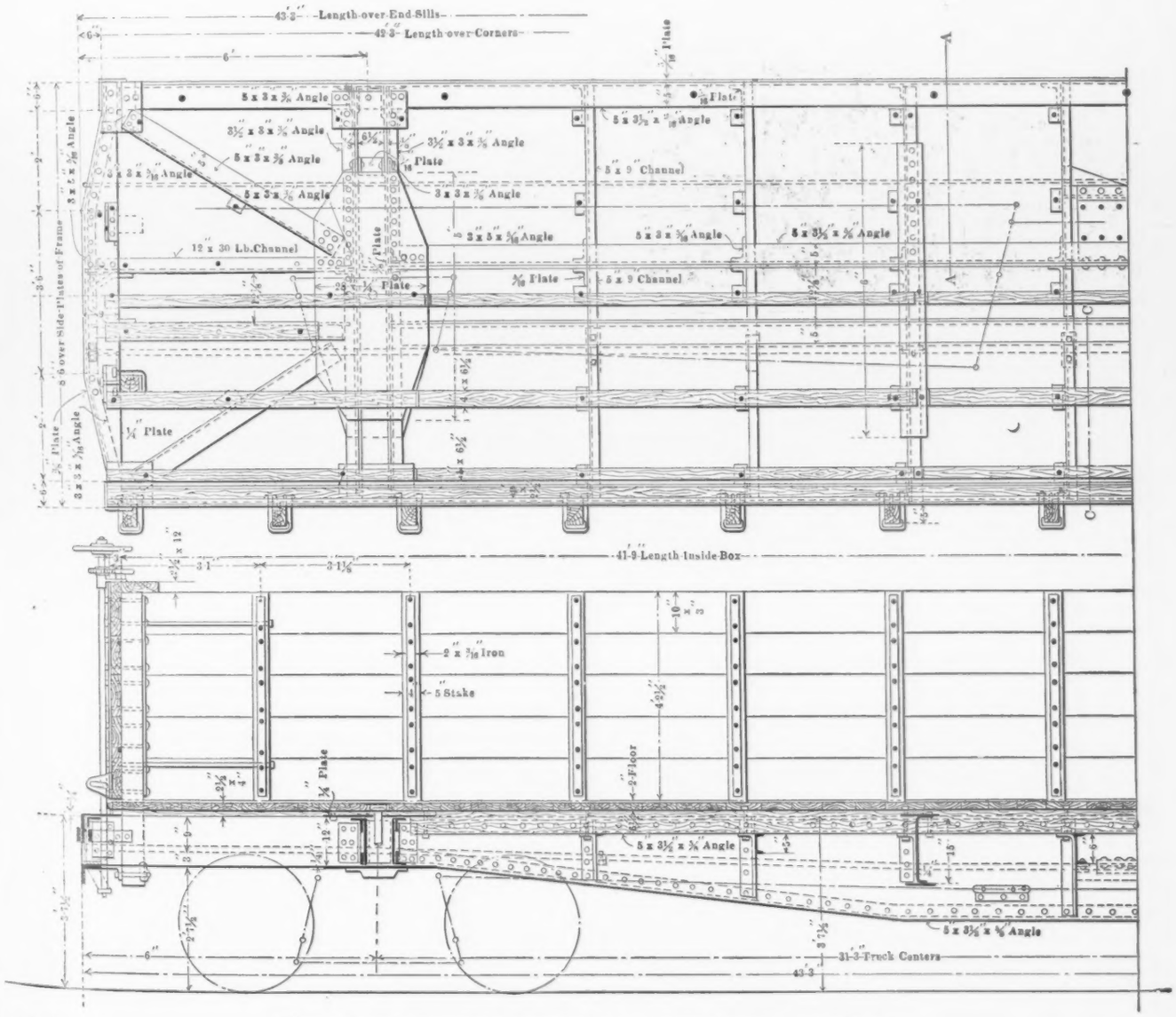
The side stakes are attached to the sills by a bolt near the bottom and a U bolt near the top of the sill. Four pairs of side stakes are tied by ¾-in. rods, which extend across the car. The sides and ends are placed outside of the stakes, giving the car a very neat appearance, and are bolted to them in the usual manner. The sides and ends of the car are tied at the corners by a ¼-in. angle plate on the outside and a 4x5-

50-TON STEEL UNDERFRAME GONDOLA CAR—ILLINOIS CENTRAL RAILROAD.





POWER VS. ECONOMY.—Railroads are not operated to save fuel, nor to have locomotives that it does not cost much to maintain and operate, and while economy must be considered as secondary to getting trains over the line, at the same time, the tractive power required, and the limits given within which to acquire this, make it necessary that locomotives be now so designed and constructed that more work will be produced per unit of fuel consumed; and the result should be economy. Whether this economy can be derived from the use of turbine, internal combustion, pneumatic or electric locomotives, or by a further practical development of the present type of steam locomotive, will depend entirely on the local conditions and requirements, and remains for the present and future progress to determine.—*Mr. Muhlfeld, New York Railroad Club.*



50-TON STEEL UNDERFRAME GONDOLA CAR—ILLINOIS CENTRAL RAILROAD.

in. stake on the inside. The car is equipped with Susemihl side bearings and Ajax trucks. Three different types of draft rigging were used—Miner, Sessions and Farlow. We are indebted for drawings and information to Mr. J. H. Wynne, mechanical engineeer.

THE MELLIN COMPOUND.

By Hal R. Stafford.*

The four-cylinder balanced compound is absorbing so much of our attention to-day that we have had little time to study the progress of our old friend, the two-cylinder, or cross-compound; indeed, many of us may think it has had its day so little has been heard of it lately. True it is, that fewer of these engines have been put into service in the United States in the past year or so than in former times, but the Michigan Central and "Soo Line" with their "Schenectady" compounds, and the Grand Trunk, whose standard freight engine is the Mellin or "Richmond" compound, would refute the charge that this type is slipping into oblivion, to say nothing of the fact that the Mellin compound has long been the standard engine on the State Railways of Sweden, and in very recent tests with other advanced types, has proved its superiority against all comers. It is a significant fact that those roads which have had the longest experience with these engines are their strongest advocates. With them they have come to stay, having long passed the experimental stage.

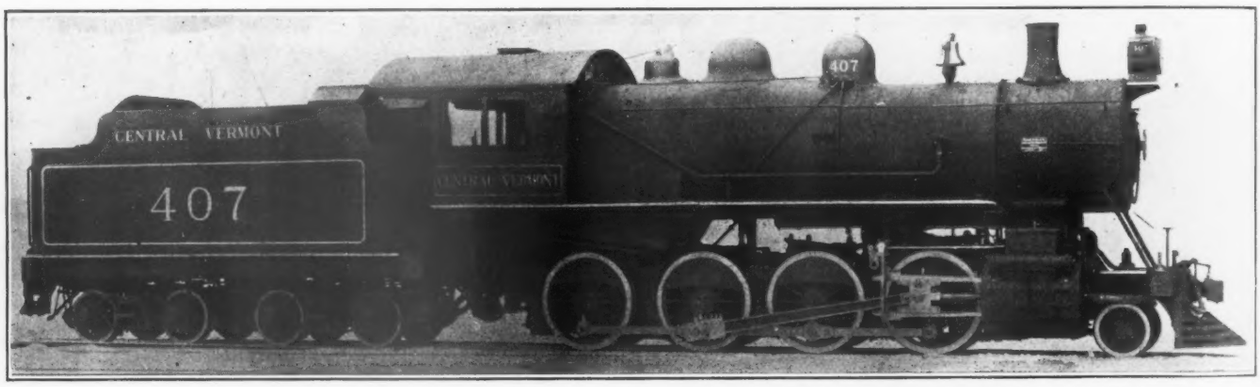


FIG. 1.—MELLIN COMPOUND CONSOLIDATION LOCOMOTIVE—CENTRAL VERMONT RAILWAY.

Weight, Total.....192,500 lbs.	Tractive Power .....38,700 lbs.	Boiler Pressure .....210 lbs.
Weight on Drivers.....167,500 lbs.	Cylinders .....22½ and 35x32 in.	Diam., Drivers .....57 in.

We find, in the two-cylinder compound, the compound principle reduced to simplest terms—the same number of working parts as a simple engine, with only the addition of an intercepting valve and a pair of by-pass valves to the low-pressure cylinder, and these latter are no longer only to be found on the compound, but are coming to be regarded as a necessity on all piston valve simple engines. A little higher in first cost than a simple engine, its saving of 20 to 25 per cent. of the fuel bill soon cancels this debt; while the repair bill, 'ong the bugbear of the motive power official, has actually proved to be less than for a simple engine, chiefly due to the saving in boiler work.†

The two-cylinder engine, in common with the other types of compound, lays claim to the advantage of large reserve power. The simple engine is cylindered to a certain factor of adhesion, say 4.5. More power than this it can never produce, even though under certain conditions, such as are met with on a severe curve when the rail elevation causes the flanges to bite the rail and thus increase adhesion, the factor might safely be reduced to a trifle over 3, thus increasing the hauling capacity on the ruling grade. The compound, on the other hand, makes use of this varying factor, and even in its normal working this can be much lower than on a simple engine, because of the more uniform turning moment due to a longer cutoff. In working simple the two-cylinder compound is less liable to slip than any other type, even though worked to its maximum; the reason will be explained in connection with the description of the Mellin system.

There are many mechanical advantages inherent in all two-cylinder compounds, over any other arrangement of cylinders in present use in this country, among them the fact that it has separate valve gears for high and low-pressure cylinders, enabling the cut-off and other events of steam distribution in one cylinder to be adjusted wholly independent of the other.

While this type has been used almost exclusively for freight service, there is every reason to believe that, with certain modifications, it might be applied successfully to passenger service. There are perfectly authentic records of an engine of the Mellin type, with 62-in. drivers, maintaining a speed of 65 miles per hour, necessitating a very high piston speed. This engine, in common with all of recent construction of this type, had improved Allen valves to the low-pressure cylinder, with considerable inside clearance, and the Allen port so modified as to enable it to act as an auxiliary exhaust port.

The Mellin or Richmond compound was one of the first successful two-cylinder compounds. The story of its introduction is interesting. In September, 1894, the Richmond Locomotive and Machine Works built an engine on the Mellin principle, embodying the experience gained in the construction of several previous engines, which engine afterwards became famous under the popular name of the "Tramp," because of its wide wanderings, having seen service in 34 States of the Union, on nearly every important road in the country. This engine was in most cases loaned gratuitously to any road desirous of investigating the merits of the compound engine, on the sole condition that the results, whether favorable or unfavorable to the compound, be made public. In most cases exhaustive tests were made in competition with "specially prepared" simple engines, and a record of the percentage of saving effected by compounding on the various lines, under various conditions, and varying degrees of prejudice, is interesting. The result was in every case favorable to the compound, the general average being a saving of coal of 26.1 per cent. and a saving of water of about 16 per cent. This famous engine is still in service, having been sold to a western road after being exhibited at the Pan-American Exposition.

Even after the famous cruise of the "Tramp," the compound had to be almost forced upon the conservative motive power world, and in many cases engines were sold for the price of a simple engine, and were made to pay their additional cost out of the saving effected, recalling the methods of George Corliss.

The Mellin system has seen little radical change since its adoption by the Grand Trunk in 1899, but a description of the machine in its latest form, as embodied in the engines lately built for the Central Vermont, and illustrated herewith, will no doubt be of interest.

Fig. 2 shows the arrangement of cylinders, the low-pressure on the right and the high-pressure on the left side of the engine, the section being taken through the receiver pipe connections, looking toward the back end. The small view

*American Locomotive Company, Schenectady, New York.

†See proceedings of Canadian Railway Club, meeting of Sept., 1904.

shows the facing for the intercepting valve head on the front of the saddle, and the outlet of the high-pressure steam passage "Y" in main view. High-pressure steam is brought from a pocket in connection with the steam pipe in the high-pressure cylinder to the low-pressure side by the bridge pipe "X" (former engines had a pipe leading from the T-head). The passage of steam from the dry pipe to the high-pressure cylinder, then through the receiver pipe to the intercepting valve and thence to the low-pressure cylinder can readily be traced on Fig. 2 by means of the arrows, so that we may turn our attention to the intercepting valve, which is the distinctive feature of the Mellin compound.

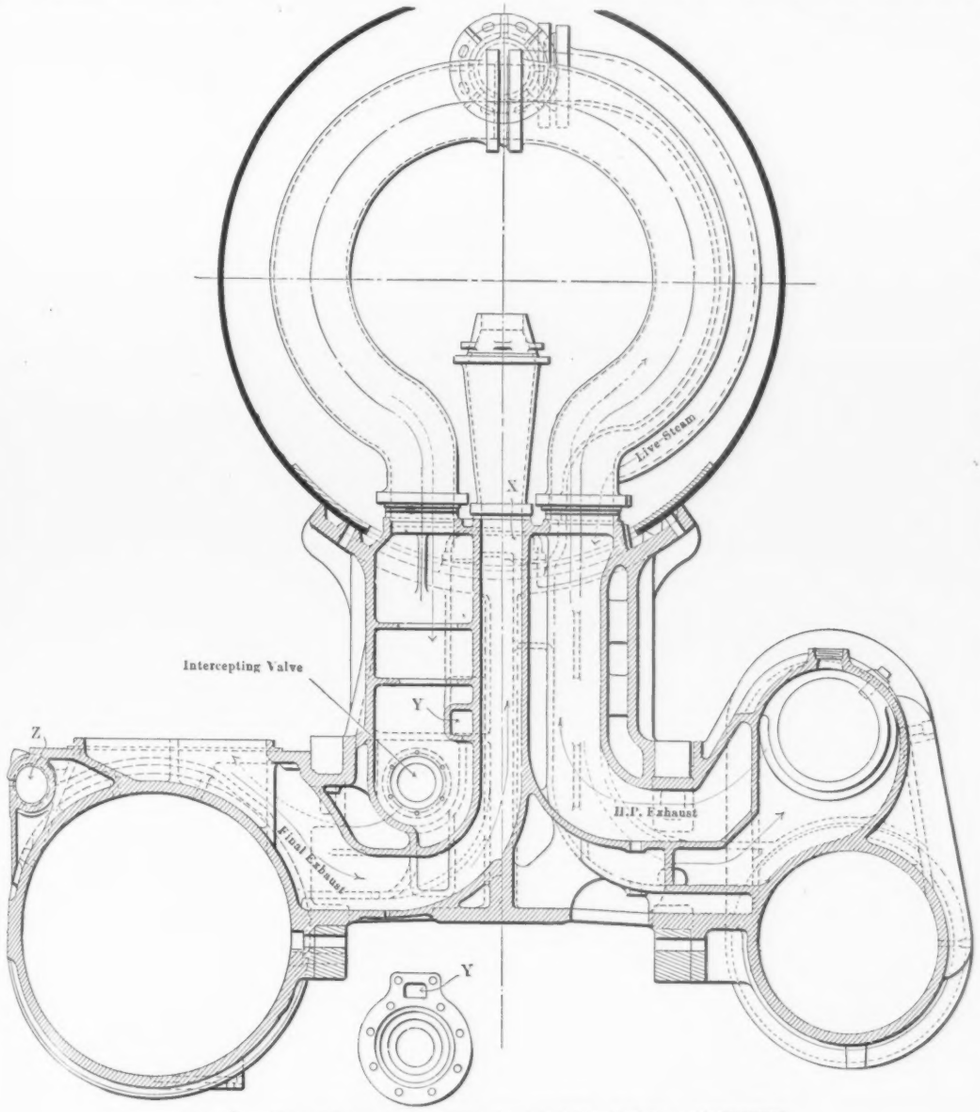


FIG. 2.—ARRANGEMENT OF THE CYLINDERS—MELLIN COMPOUND.

A glance at Fig. 3 will show a machinist that the machine work on this valve is all lathe work, except for the drilling of the holes in the cover, etc. There are no expensive operations requiring special skill or special machinery. A fairly good lathe hand can do the job and do it right the first time.

Its operation is as simple. In starting, live steam enters through the head, and passing into the port A, moves the reducing valve to the right by virtue of the difference in the areas "Z" and "Y." The point B engaging with the shoulder on the main stem, closes the intercepting valve and at the same time live steam enters through the reducing valve. After a few revolutions sufficient pressure is accumulated by the exhaust of the high-pressure cylinder at the right of the main valve to force it open against the pressure of the live steam on the differential area of the reducing valve. This opens the intercepting valve and at the same time closes the reducing valve. The engine is then working compound. The reducing valve being loose on the stem of the main valve, is capable of sufficient movement to close the live steam inlet independent of the movement of the main valve, thus working as an ordinary differential reducing valve to restrict the pressure in the low-pressure cylinder to the amount determined upon in equalizing the work of the two cylinders.

In case it is desired to work the engine simple for a longer period in starting, the emergency exhaust valve is opened by admitting steam behind the piston C—a three-way cock within easy reach of the engineer performs this function—which allows the exhaust from the high-pressure cylinder to escape to the atmosphere and prevents the accumulation of pressure behind the main valve. In changing from compound to simple, the balancing piston and chamber, features peculiar to the Mellin compound, come into play. The balancing chamber D is of small volume and is completely cut off from communication with other passages except as shown. It is open to the receiver through six ¾-in. holes in the balancing piston, which ordinarily suffice to equalize the pressure between them. But upon opening the emergency exhaust valve this chamber is emptied more rapidly than the area of these holes can supply it, with the result that the intercepting valve is closed instantly by the pressure on the balancing piston. This prevents the loss of pressure in the receiver which would be necessary to close the valve in the ordinary manner, and avoids a drop in the power of the engine right at the "sticking point."

The air dash pot, at the extreme left of the drawing, needs no explanation. It is only meant to prevent slamming of the valve during closing, as the action of the valve during opening is very moderate—generally in two or three impulses.

The following formula may be used to determine the pressure in the receiver when working simple, or reducing valve pressure, which we will represent by p, and the receiver pressure required to open the main valve, or p_1.

Let a = area at Y (Fig. 3).
Let b = area at X
Let c = area at Z
Let P = boiler pressure.

Then

$$\frac{P\ (a-b)}{a-c} = p \text{ and } \frac{P\ (a-b)}{a} = p_1$$

The ratio of cylinder volumes, in the Mellin system is made 2½ to 1, as nearly as may be, keeping the diameters to the nearest ½ in. The most delicate problem in designing a two-cylinder compound is to equalize the work between the high and low-pressure sides under varying conditions. This is done by carefully adjusting the lap of the valves, and while

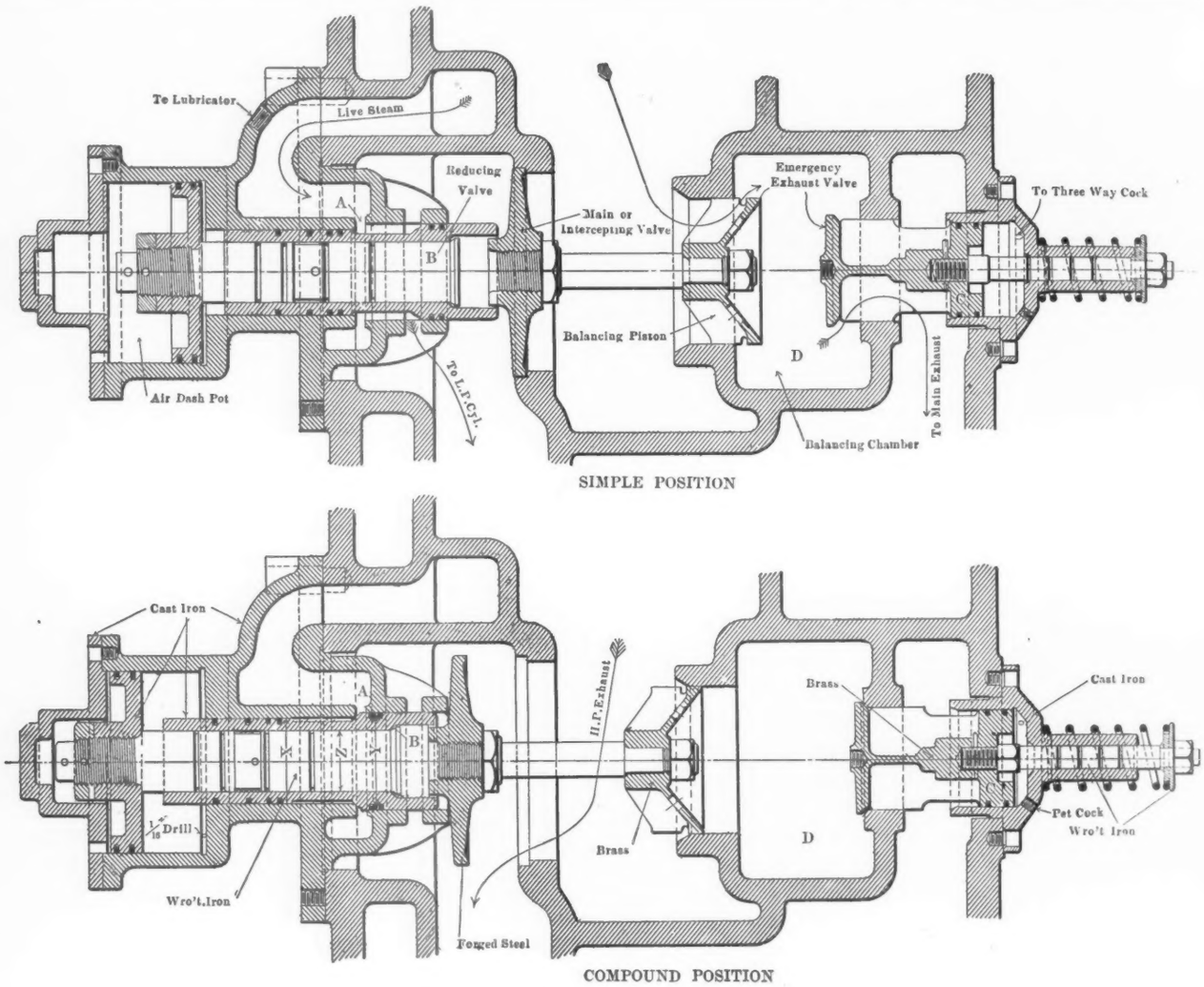


FIG. 3.—INTERCEPTING VALVE—MELLIN COMPOUND.

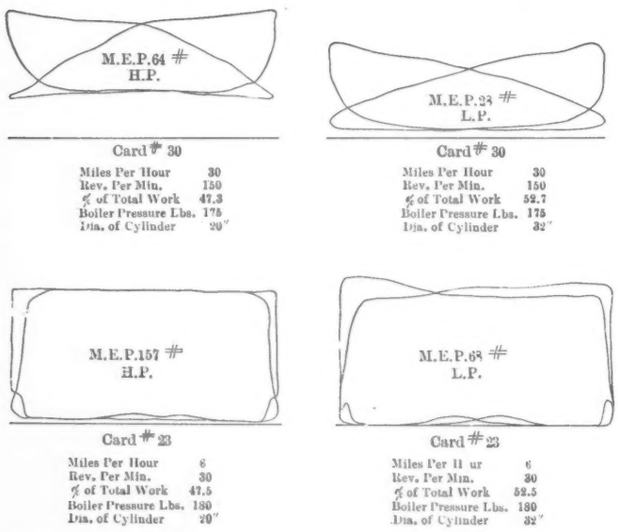


FIG. 4.—INDICATOR CARDS FROM MELLIN COMPOUND, 4—6—0 TYPE FREIGHT ENGINE—C. C. C. & ST. L. R. R.

the result can only be approximate, the closeness of the approximation may be judged from the indicator cards shown in Fig. 4, which were chosen at random from a set taken from engine number 350 on the "Big Four" in 1897. The cards taken during this test show a maximum variation of about 4 per cent. either way from exact equalization, both in simple and compound position. That may be called near

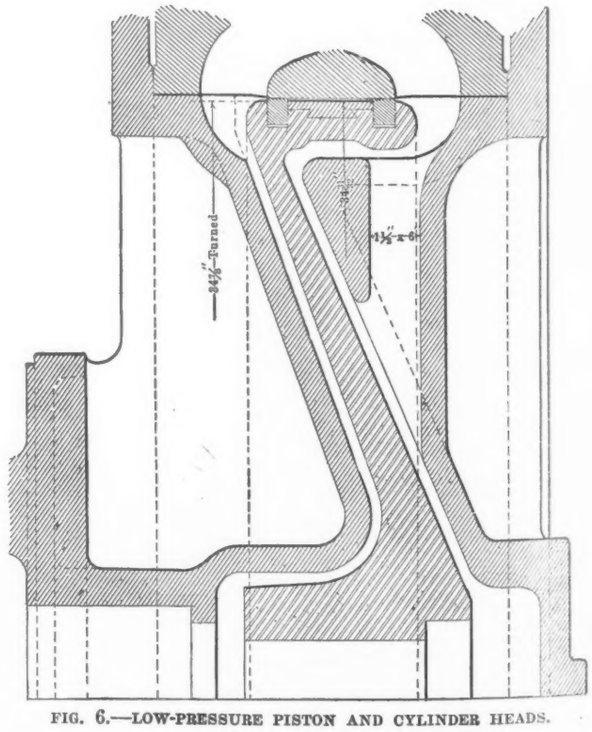


FIG. 6.—LOW-PRESSURE PISTON AND CYLINDER HEADS.

enough, since we may get a difference of 25 per cent. in a simple engine, by mere variation in lubrication! In general,

less attention is given to equalizing the work in the simple position than in the compound, since this is an abnormal condition, as is conveyed by the word "emergency"—applied to the simpling valve.

The experience of builders and users of compound engines has taught them that for the present at least the engineer must be prevented from using the simpling valve unnecessarily, by some other means than persuasion. He soon finds that, under certain conditions, the opening of the three-way cock has the same result as of "another engine pushing from behind," and in his laudable zeal to get over the road, his hand seeks the little brass lever too often for the good of the coal pile. For this reason the area of the reducing valve, a—b in the formula, is purposely restricted, so that above a certain speed—about 10 miles per hour—the wire-drawing of steam through this opening so reduces the receiver pressure as to make further acceleration impossible without going into compound. The restriction of this area fulfils another purpose, that of preventing the slipping of drivers when working simple by this same wire-drawing effect, as soon as the low-pressure piston begins to travel at undue speed, as in slipping.

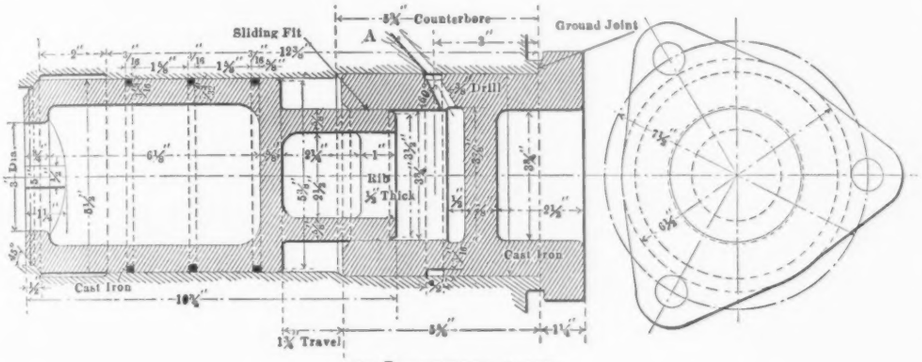


FIG 5.—BY-PASS VALVE.

The office of the by-pass valves, Fig. 5, used only on the low-pressure cylinder, is so well understood as to need little explanation. In drifting, the effect of so large a piston acting as an air pump to force air through the exhaust pipe is to create nearly as good a draft as when working steam; moreover, the work thus expended on one side of the engine, with its vertical disturbing forces due to the angularity of the main rod, makes a hard riding engine when drifting down grade at high speed. To do away with these undesirable features is the purpose of the by-pass valve.* A pair of these are placed in the chamber "Z," Fig. 3, one closing each port, with a passage 5 ins. in diameter connecting the two. The hole "A," Fig. 5, being in communication with the steam chest, the pressure therein, when working steam, keeps these valves closed. But on shutting the throttle, a partial vacuum is soon formed in the chest, which acts on the ends of the valves, causing them to open and establish direct communication between the opposite ends of the cylinder. The action of these valves is so satisfactory that they have been extensively copied in foreign countries.

*See *Railroad Gazette*, Jan. 25, 1901, "Progress of Two-Cylinder Compound Locomotives."

Drawings are shown of the low-pressure cylinder heads and piston, which have some original features; and the low-pressure valve, showing the liberal exhaust clearance; also the Allen port clearance—this port is usually made line and line with the edge of the steam port on other engines.

The engine-man requires little special knowledge to handle this engine—he will be glad to learn the use of the lever which will help him over the hard spots. All else he will need to know, provided he is familiar with the simple engine, is that a cross-compound may also be disconnected and brought in on one side, but he must always remember *to open the emergency valve* in either case, whether the disabled side be high or low pressure. He will soon learn of his own accord when it will help to simple his engine, and when it will do no good.

In conclusion, we would like to call the attention of those who say that the capacity for growth of the two-cylinder compound is limited by the size of the low-pressure cylinder, that the limit is at least a liberal one, and comes near the point where we begin to meet with other limitations. We refer to the table giving the principal dimensions of the engines for the Central Vermont, illustrated at the beginning of this article, on which the new power for the Grand Trunk, now building, is based.

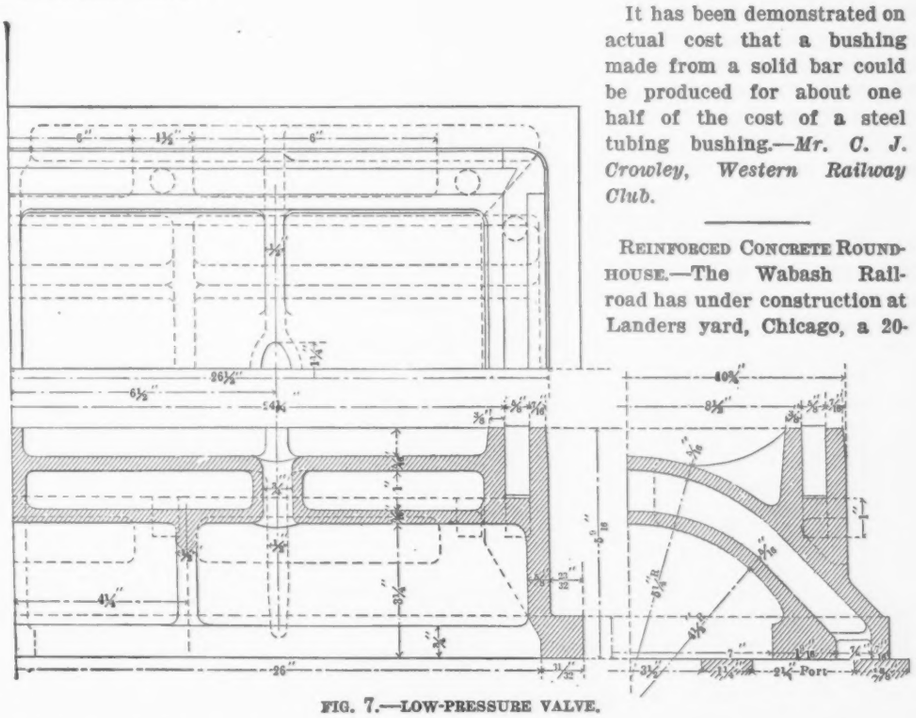


FIG. 7.—LOW-PRESSURE VALVE.

It has been demonstrated on actual cost that a bushing made from a solid bar could be produced for about one half of the cost of a steel tubing bushing.—*Mr. C. J. Crowley, Western Railway Club.*

Reinforced Concrete Roundhouse.—The Wabash Railroad has under construction at Landers yard, Chicago, a 20-stall roundhouse, the outer and end walls of which are of reinforced concrete. The engine pit walls are of plain concrete and the pit floor is of paving brick laid on edge on a sand bed and grouted. The house is 81 ft. 6 ins. deep; the transverse roof timbers are supported by three intermediate posts, 10 x 10 ins., in addition to the outer wall support and the column or door post at the inner wall.

The Interborough Rapid Transit Co., of New York City, is said to be carrying an average of 1,250,000 passengers a day.

One result of extensive water softening is to very greatly decrease the cost of roundhouse repairs.

VALUABLE ADVICE TO COLLEGE MEN.

Mr. H. W. Jacobs, engineer of shop methods and tools of the Atchison, Topeka & Santa Fe Railway, recently delivered an address before the engineering students of the University of Kansas, at Lawrence, Kan., which was exceedingly valuable, not alone to college men, but to all those who are interested in railway shop methods, and we regret that we are not able to reproduce a greater portion of it. At the beginning of the talk Mr. Jacobs gave some splendid advice to the students as follows:

"In the past few years an entirely new profession has developed, known as commercial engineering, brought about by the keen competition of manufacturers. The engineer of to-day who is not able to take hold of a proposition and figure results from a business standpoint is likely to be left at the post. The Panama Canal is not being built as a triumphal exploit of engineering skill, but because it will cheapen the cost of ocean transportation; the Lucien Cut-off on the Southern Pacific, with its thirteen miles of trestle work over Great Salt Lake, although it represents the acme of achievement in railroad construction, was not built as a scientific experiment, but was brought about because by this method Oriental freight could be put from San Francisco into the Eastern markets at so much less per ton.

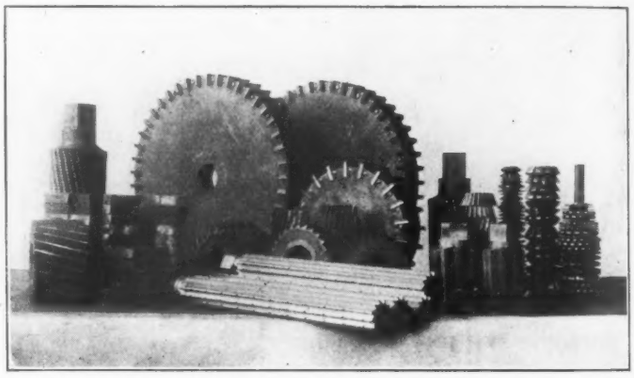
"This is the great and, in fact, the only idea for any young man to keep in mind when leaving college and starting in for himself. The majority of men within my hearing to-day will, no doubt, on the completion of their college course, find their way into the employ of some factory, railroad shop, steel mill, bridge works, or some manufacturing concern. The question will be, then (if the young man intends to make his mark), not how nicely can he sketch a plan on a piece of tracing cloth, or how clearly can he elucidate upon the many theories of applied mechanics, but how much of a saving can he show in shop management, how much can he cheapen the production of some particular article? What can he do to help tone up the plant so that the best results can be obtained from his particular department? These are the problems he will have before him, and these only must be kept in mind if he expects to make a showing worthy of note, and of sufficient importance to attract the attention of the head of the concern.

"Among practical, everyday shop men the average technical graduate is given very little consideration. This, of course, may be the misfortune of the shop men or it may be the effect of the attitude of the graduate. The fact remains that there is a great deal of truth in the statement. In nine cases out of ten when a technical graduate secures a position in a shop of any kind he is considered of about as much use as an ordinary helper, or he is classed under the rather ambiguous title of special apprentice, and duties are assigned to him in about the same proportion. The graduates themselves, in my experience, are greatly responsible for this state of affairs. They enter a shop knowing almost to a certainty that this exists, yet in many instances they make no effort to change the general opinion. They take hold of the work that is given them in a rather perfunctory manner, and seem incapable, in many cases, of developing ideas on the subject at hand, and in a short time they find themselves moving in the same old rut of shop routine that may have existed ever since the shop was built. Instead of keeping their eyes open for chances for improvements and taking them up in the proper manner, they are content to allow things to drag along with as much unconcern as if they had never been blessed with advantages of any kind.

"This is the point that I want to impress on your minds: *Be on the lookout for improvements in methods of all kinds at all times.* Don't think for a moment that I am decrying mechanical training simply because a great many of the graduates have made seeming failures. The trained men are the men that are needed; the technical men are the men that have to fill the important places in all cases. They must be the pioneers!

"The theories of to-day become the practices of to-morrow, and the men who can look ahead and anticipate a demand are the men that are going to win in the long run. Have a systematic line of investigation that you intend to carry out if ever you enter a shop, no matter what may be its kind of output. Keep the cost of production ever in your mind, and let no chance escape you if you see an opening of any kind for improvement.

"If you enter a machine shop don't be content with doing whatever little detail you may be assigned to on some particular bench or machine. Note the entire layout of the plant. See what kind of power they are using. Note the method of transmission. Keep an eye on the class of machines in service; also their condition. Check up the speeds of shafting at the first opportunity. Note the method of making tools. Read up on tool steels. Keep in touch with the newest and latest catalogs on machinery. Compare the methods with other shops. Check the price lists of similar articles made in other parts of the country. In fact, familiarize yourself with every item of interest in any way connected with the article in question. You will be surprised how soon you are noted by some official of the organization. I have had too many years of actual experience in shop work not to know that I am speaking the exact truth. If you are in the designing department, don't put in your time seeing how nice a set of lines you can embellish with graceful curves, but see how much machine work you can eliminate in the assembling room. This is very essential: No one will deny that the sale of any article, no matter what it may be, is very greatly affected by its general appearance. It must look neat, as well as be reliable, but the days of elaborate finish are past.



MILLING CUTTERS, REAMERS AND HIGH-SPEED TOOLS MANUFACTURED ECONOMICALLY IN A RAILROAD SHOP TOOL ROOM.

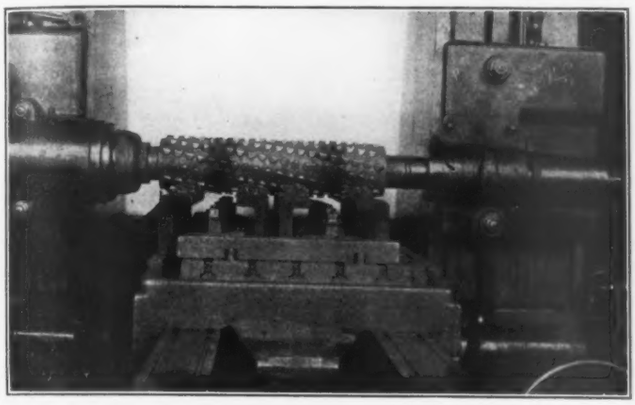
"There was a day when buildings were equipped with heavy trappings of all descriptions and locomotives were encircled with rings of polished brass, but the best sellers of all merchantable articles to-day are those of the plainest finish.

"It is not how nice does a locomotive look to-day; it is how many tons can it haul. It is not what sort of a polish do you have on your line shaft; it is how many revolutions can it make a minute. It is not what style of architecture is your furnace built in; it is how many tons of pig iron can it turn out in twenty-four hours.

"I believe, however, I have talked long enough on generalities, and I think, perhaps, I could demonstrate to you much more clearly with the following illustrations, than I could explain otherwise what I mean when I speak of 'toning up a plant.'"

After this introductory address about 150 lantern slides were shown illustrative of these methods of "toning up" as applied to railway shop work. The first group of slides dealt with the general lay-out and of material storage and handling arrangements of a large shop. The next group dealt with the methods of improving machine belting, this being one of the first points to be taken up when shop betterment is undertaken, as by this alone the efficiency of the machines will be increased as a whole from 10 to 30 per cent. The third series showed the changes in shop methods, machine tools and de-

vices, incident to the use of the new high-speed alloy tool steels developed since the introduction of the Taylor-White process. After these were shown some views of machine betterments necessitated by the intensive shop production due to the use of these high-speed heavy service tools, such as the substitution of steel for cast iron gears, the increase in size of driving and feed pulleys and gears, the strengthening of steady rests, housings, etc. Then followed illustrations of a number of



IMPROVED METHOD OF MILLING FOUR ROWS OF SHOES AT ONE TIME.

special devices for use in railway shops, showing how, by the exercise of a little ingenuity in the tool room, the cost of machining many special locomotive parts could be greatly reduced.

Next after these were shown special jigs for use on the machines, and then followed a long series of slides on the subject of tool standardization for an entire railway system, i. e., standardizing punches, drills, reamers for crosshead, knuckle pin, and ball joint work, flue rollers, etc. A number of views were then given of a recent very light air motor that has many advantages for work in close quarters, and on account

LARGE COMPOUND MILLING CUTTER FOR FINISHING SEVEN SURFACES AT ONE TIME.

of its efficiency. Following these, various devices for use in erecting floor work were shown, cylinder boring machine, valve facing device, a convenient portable air hoist for main air reservoirs on engines, guide lining device, valve bushing extractor, etc. Mr. Jacobs concluded his address with a very interesting description of the individual effort system (See AMERICAN ENGINEER AND RAILROAD JOURNAL, February, 1906, page 61), for rewarding labor as applied in a large shop to effect economical production and to reduce to a satisfactory basis the wage problem.

Correspondence is one source of delay, and if it can be cut down in any department, the service is benefited.—*Sydney Gilliard, Pacific Coast Railway Club.*

LIGHTING MACHINE TOOLS.

Although articles and comments have appeared from time to time on shop lighting, very little has been said specifically on the lighting of separate machine tools. Many shops could make much-needed improvements if attention were given to this important detail, as there are very few shops that do not have machines installed in dark corners, and at this season of the year in all shops artificial light must be depended upon entirely for a part of the time. A man can never work as fast when he is compelled to feel rather than see what he is doing, and the slow rate at which work is turned out with inadequate lighting is in itself a sufficient incentive to better the arrangements. Then again, the workman, after he has made a few mistakes in setting his tool and has reached the point of exasperation, loses pride in his work, and when this happens, both the management and the workman are the losers.

Lights for machine tools should be placed on brackets or stands in such a manner that they are held rigidly. The support should be provided with adjustable arms, so that the lamp may be set down close to the work. Such stands or brackets may be easily constructed in the machine shop, and the cost of the material will be practically nothing. By all means, the lamps should be provided with shades of some sort. Sometimes large shades are not permissible, as they prevent placing the lamp as near the work as desirable. But there are a sufficient number of shades and types of shades on the market to permit of a selection of a style most suitable to each machine.

Often, however, one lamp, even if it be a 32-candle power one, is not sufficient to properly light a machine. If so, the cost of current for extra lamps should not be reckoned, and especially so in a street railway shop, where the current usually costs about .3c. per kilowatt-hour. Assuming this rate, a lamp-hour costs about .015 cent. At this cost, it is a rather safe risk to install all the lamps which have the least possibility of being used.

It isn't necessary to employ an illuminating engineer to place lamps properly about a shop. All that is required is to give the workmen to understand that the lamps will be fixed for them as they may desire. If such a hint was given them and their wishes were then followed, in many shops much more satisfactory machine work would be turned out, and it would be executed much more rapidly.—*Street Railroad Journal.*

MASTER MECHANICS' AND MASTER CAR BUILDERS' CONVENTIONS.—The committee on arrangements of the Master Car Builders' and American Railway Master Mechanics' Associations has decided, after full investigation, that it would be more satisfactory to hold all business sessions of the two associations in the Sun Parlor on the outer end of the Steel Pier rather than in the hall over the entrance to the pier at the shore end. The railroad men will therefore pass through the exhibits in going to and from their meetings. Under the first agreement with the Hotel Men's Association, the use of the east half of the pier was assigned for exhibition purposes on condition that the public be excluded, but as this space has been found inadequate, the entire pier has been procured with the understanding that the public be admitted. It is believed the presence of the public on the pier will not inconvenience the exhibitors to any appreciable extent, and by this concession a large amount of additional exhibit space is procured.

RAILROAD TIES.—The number of cross ties in use on the railroads of the United States is estimated to be about 620,000,000; the number used annually for repairs and for extension of tracks is estimated to be from 90,000,000 to 110,000,000, requiring, we may say, the entire product of 200,000 acres of woodland annually.—*Joseph T. Richards, American Forest Congress.*

RIEGEL WATER TUBE LOCOMOTIVE BOILER.

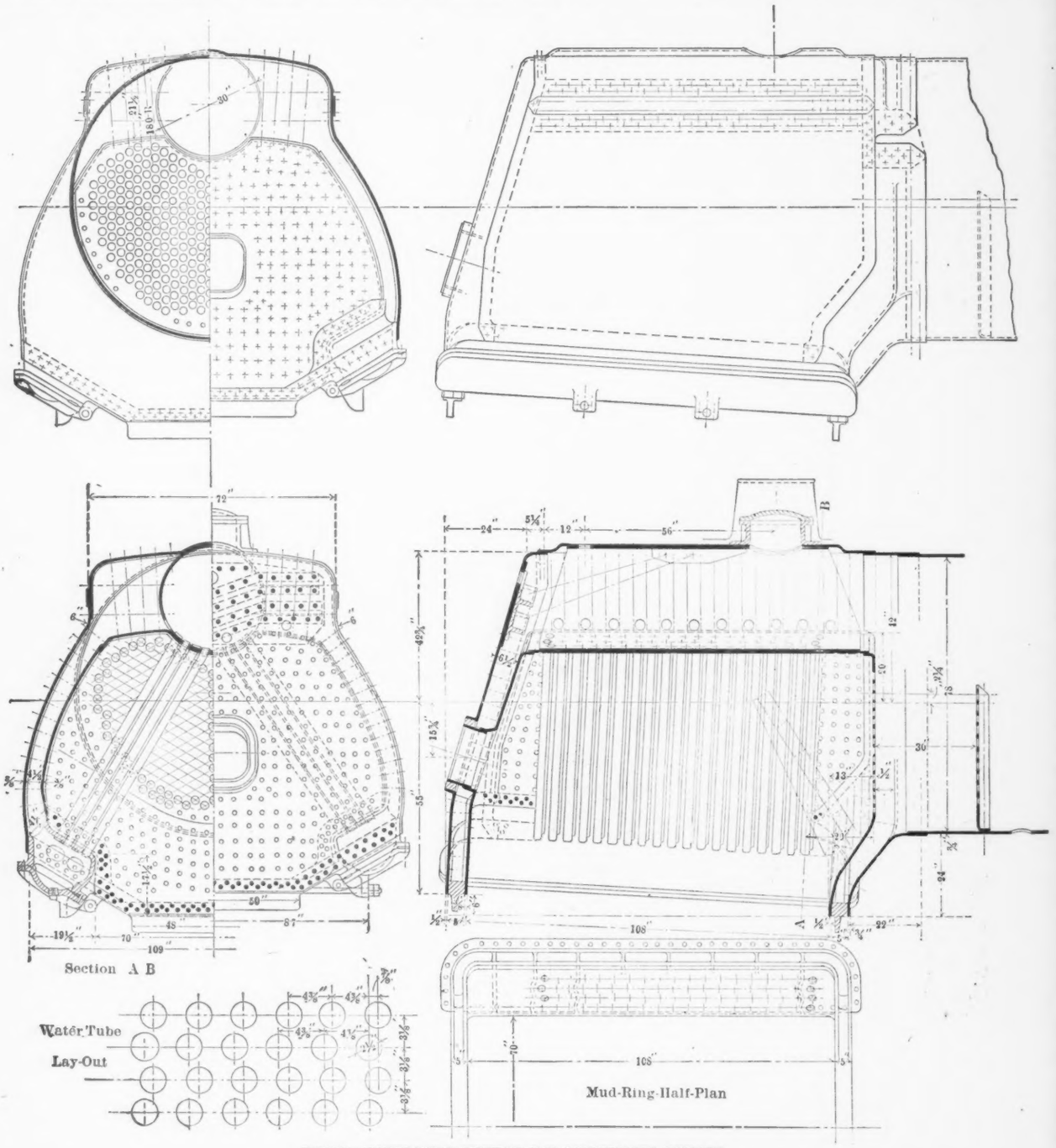
The illustrations herewith show a new design of locomotive boiler which is arranged to take advantage, as far as possible without completely revolutionizing the present construction, of the advantages of the water tube method of steam generation. This boiler was designed by Mr. S. S. Riegel, who furnishes us with the following description of it:

Water in rapid circulation, over intensely heated surfaces, will absorb approximately five times the heat absorbed by water not in circulation, or of which the circulation is restricted, and we learn from the experiment of others that fuel burned at a normal rate will develop double the quantity of heat we may expect from it at a high rate of combustion.

It is maintained that the rate of combustion is so high and the passage of the heat from the grates to the stack is so rapid that, during the interval of time required in transit over this course, only a small part of it can be absorbed by the water; in other words, we are forcing our boilers beyond their capacity of heat absorption, and as it is quantity of heat absorbed rather than heat developed that generates the steam, it is equally important that the boiler be a generator as well as a furnace.

It is established that, in general, the most efficient generator is the one that has a good, definite and active circulation of the water over the heating surfaces and which has its heating surfaces located in the right place.

With the object of providing definite cycles of circulation of water over the heating surfaces and of locating these surfaces in the best possible places, rather than to provide a greatly increased heating surface in the boiler, the design shown in the illustrations has been chosen.



RIEGEL WATER-TUBE FIREBOX FOR LOCOMOTIVE BOILERS.

It consists of a combination of water tubes with the flue boiler, and is, in brief, a re-design of the firebox.

The mud ring is made of cast-steel and has water-pockets cast in it at the sides beyond the grates, throughout its length, thus forming lower terminations for two nests of water tubes which extend from them diagonally upwards to the crown-sheet, which is slightly depressed to keep the upper tube terminations flooded. The water-pockets have staying ribs cast

integral with them, and the ribs are provided with holes to permit freedom of circulation.

The water-pockets are covered over at the bottom by removable plates to provide openings through which the tubes can be inserted and expanded, and through which the boiler can be easily examined and the tubes cleaned. The plates are hinged forward and back so they will swing back out of the way when the bolts which secure them in place are removed and so they can be swung back into position by a few men, thus avoiding the necessity of lifting them into place. The steam joints are made with sheets of soft metal.

The water tubes are so spaced that it is possible to pass a boring bar between them in order to remove defective staybolts, and they are kept sufficient distances from the flue, door and side sheets for accessibility for inspection and repairs.

The steam space is of the Belpaire type, for greater steam capacity and for simplicity of staying. Above the crown-sheet is provided a staying cylinder which, with the crown-sheet, makes double thickness at the crown for tube ends. This cylinder has sufficient flexibility to take care of expansion and contraction. Above the crown-sheet in the roof of the boiler is provided a combination manhole and pop-valve turret. This provides a ready means of access for inspection. The usual fire-brick arch is placed forward in the firebox; this diverts the gases and causes them to pass between the water tubes and impinge upon the side sheets. The gases which have been cooled by striking the water tubes are re-heated by the gases which pass around the nests of tubes and over the arch. In this way the heat is made to linger in the firebox, which, together with the increased circulation, gives the water a chance to take it up.

The illustrations show a re-design of the boiler of the Southern Railway Pacific type fast passenger engine with a dome course of 79½-ins. diameter. The grate area is approximately as before, 70x108 ins., but the firebox surface has been increased 583 sq. ft., making approximately 768 sq. ft. of firebox surface. This surface is so considerable, and it is so arranged, as to cause perfect and direct cycles of circulation of water upward through the tubes and about the firebox in general, which will cause rapid heat absorption, prevent scale formation, make expansion and contraction uniform and stimulate evaporation and cause liberation of steam, making it possible to reduce combustion to approximately one-half the present rate. That the circulation about the firebox may have additional freedom, a sheet is placed 30 ins. forward of the back tube sheet; the top of this is below the upper flues and serves as a dam to keep the cold inlet water forward and away from the firebox until it has been warmed to 300 or 312 degrees, when it overflows the dam and meets the circulating currents about the firebox. The necessary flue holes in this dam are not a tight fit to the flues.

It is believed that boilers constructed along these lines can be depended upon for reliability and economical maintenance, and that, as the water tubes protect the sheets, there should be freedom from cracked sheets, leaking flues, leaky seams and broken and leaky staybolts. There should be "continuous development of maximum horse power within the capacity and endurance of the average fireman," and we should have an "efficiency approaching as closely as possible to that of the best stationary boilers."

When we consider that from 40 to 45 per cent. of the total quantity of the steam produced is generated by the firebox, it must be apparent that reliability and low cost of maintenance must depend mainly upon freedom of circulation about the firebox, and it follows that a square foot of direct or firebox surface must have a value far in excess of the flue surface, and, in fact, it has approximately seven times the value. From experiment the average evaporation per square foot of firebox surface is 28.3 lbs. and the maximum evaporation of the flue surface is 4.7 lbs. per sq. ft. The reason for this is probably due to the gases becoming divided and reduced in temperature to such an extent, in their passage through the flues, that the combustion ceases in the flues, while in the firebox there is continuous combustion.

Therefore, an increase in direct or firebox surface of 583 sq. ft. would, theoretically, be the equivalent of approximately 4,081 sq. ft. of the average flue surface. If this can be sustained in practice remains to be controverted. There is no doubt, however, that the greatest effect due to the heat given off by the combustion of fuel is in the region of the firebox. Therefore, to increase the boiler horse power, stimulate evaporation by an increased circulation of water where the heat is most intense.

The following tables show the principal dimensions of the Pacific type locomotive mentioned above, which is now in service, and also what the dimensions would be as equipped with a water tube boiler:

	Fire Tube.	Water Tube.
Grate area	54 sq. ft.	51 sq. ft.
Heating surface of flues	3,700 sq. ft.	4,064 sq. ft.
Heating surface of firebox sheets	185 sq. ft.	230 sq. ft.
Heating surface of water tubes		538 sq. ft.
Heating surface of total	3,885 sp. ft.	4,832 sq. ft.
Length of flues	20 ft.	20 ft.
Number of flues	314	345
Diameter of flues (O. D.)	2¼ ins.	2¼ ins.
Average length of water tubes		5 ft. 5 ins.
Number of water tubes		152
Diameter of water tubes (O. D.)		2½ ins.
Water tubes secured by		Expansion
Ratio of heating surface to grate surface	72	95
Percentage of firebox surface to total	4.7	15.9
Weight of engine, total	219,690 lbs.	225,000 lbs.
Weight on drivers	143,190 lbs.	145,000 lbs.
Weight on trailing truck	38,800 lbs.	42,000 lbs.
Weight on leading truck	37,700 lbs.	38,000 lbs.
Firebox	73x109 ins.	70x108 ins.
Flue centres	3 ins.	3 ins.
Driving journals, main	10x12 ins.	10x12 ins.
Driving journals, F. & B.	9x12 ins.	9x12 ins.
Trailing truck journals	8x12 ins.	8x12 ins.
Tender truck journals	5½x10 ins.	5½x10 ins.
Valve travel	5½ ins.	5½ ins.

THE DRAFTSMAN'S FUTURE.

To the Editor:

My subscription to your Journal expires, I believe, on April 1st of this year. I have been a subscriber for a number of years and have found your paper very helpful and it is with reluctance that I have to ask you to drop me from your subscription list.

I entered railroad work about seven years ago as a machinist apprentice and rose to the position of draftsman in less than two years, the remainder of my four years apprenticeship was spent at the board. Consequently, your articles on the future of the draftsman were quite interesting to me, especially so as they came about the time that I began to realize that the drafting room was a corner in which a young man would soon be lost sight of and forgotten, although he might make a hard struggle to get out in the race again. I fought my battles, but with no success, except promises of what the future would bring. Three years ago I had an offer to enter the telephone field of which I had absolutely no knowledge, and as I had become disheartened by the treatment I received from the railroad, I accepted this offer and to-day my salary is double that which I received from the railroad company when I left them, which makes it equal to that of the leading master mechanic of any of our trunk lines. Since leaving the railroad I have received requests from railroad people to send them draftsmen, but have been unable to supply the demand. I note in the last issue of your Journal that you state that your list of draftsmen is also exhausted. It seems to me that it is about time the railroad companies of this country were awakening to the fact that if they expect to keep draftsmen, they must make positions in the drafting room in the line of promotion to such positions as master mechanic. In this way they would be able to draw from the shop bright young men, who do not care to take up this work, as they believe that if they do so they will enter the side track and the dispatcher will fail to give them the necessary orders, which will give them the right to the main track to enable them to reach the home terminal. This subject has been a pretty well hashed over in your columns, but I fear there are still a great many railroad officials who do not see the matter in the proper light. None of the above is intended as an adverse criticism of the officials with whom I came in contact. I think the trouble was higher up.

X. Y. Z.

I firmly believe that the really great savings to be made in our shops are the small savings when added together, the savings on the small items.—*Mr. A. E. Manchester, Western Railway Club.*

50-TON STEEL GENERAL SERVICE DROP BOTTOM GONDOLA CAR.

DROP BOTTOM GENERAL SERVICE STEEL GONDOLA CAR.

The Frisco System is receiving 200 all-steel 100,000-lb. capacity drop-bottom general-service gondola cars, half of which are for the Chicago & Eastern Illinois Railroad and half for the Kansas City, Fort Scott & Memphis Railroad. When the drop-doors are closed the floor of the car is flat, and to all appearances it is an ordinary flat-bottom gondola car without hoppers. When the doors are open the car will discharge 99 per cent. or more of the load without shoveling; they may therefore be used for coal or gravel and all kinds of material that will require dumping, or, because of the flat surfaces, they may be shoveled out where dumping is not feasible, or they may be used for the loading of lumber, pipe, bar iron, brick, sewer pipe or any material which cannot conveniently be loaded in hopper cars.

GONDOLA CAR AFTER DUMPING.

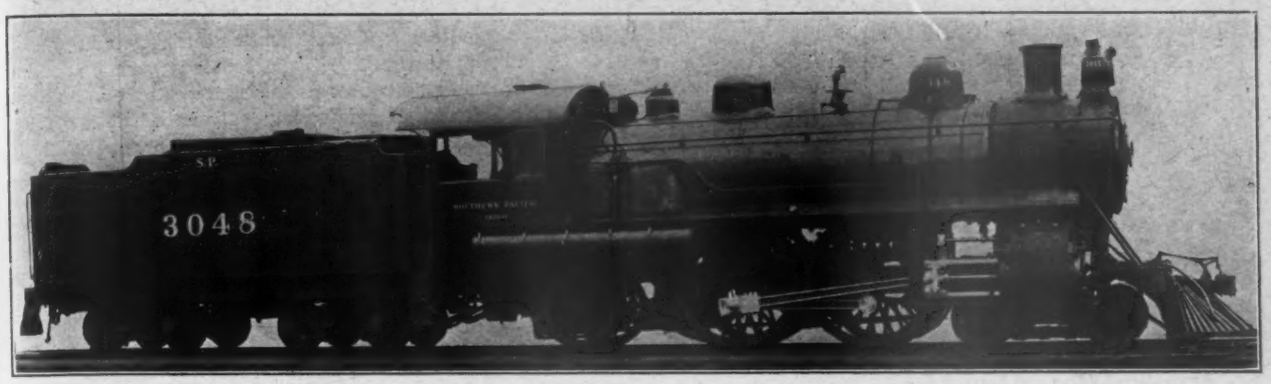
On March 7th a test of one of these cars was made at the works of the National Tube Company, McKeesport, Pa., to demonstrate the rapidity with which the car could clear itself in dumping. The car was loaded with 99,300 lbs. of run of mine coal, which was somewhat less than the capacity of the car level full. One of the illustrations shows the car on a trestle in the process of dumping part of the load. The other view shows an interior view of the car after dumping. One end of the car over the truck retained more of the load than the other end, probably because the end was on a curve and the elevation decreased the angle of inclination of the two doors immediately over the truck. It was estimated that not over 600 or 700 lbs. of coal remained in the car, or less than .7 of 1 per cent. of the total load. The greater part of this would probably have been displaced if the car had been jarred by the coupling on of an engine. The time required for dumping was about 6 seconds for each half of the car, and the time consumed in closing the doors was about one-half a minute for each of the four sections. The car could be placed, dumped and the doors closed to form a flat-bottom gondola car by two workmen in 4 minutes or less.

One of the illustrations shows the interior of one of the cars with the doors closed.

Practically the entire floor of the car is made up of drop-doors, 16 in all. The 8 doors over the trucks drop to a clear opening of 23 ins. and the 8 in the centre of the car have a clear opening of 26 ins. The centre sills are compressed to form an inverted V and are riveted to a T-shape, the flange of which forms the centre ridge of the car and is only 4 ins. wide. The sills are reinforced with angles at the lower edges. The body bolsters are built up of plates and angles and are 7 ins. wide. The cross-bearers are of pressed steel shapes and present a 3-in. top surface. The doors are operated by what is known as a "creeping shaft" mechanism, which is carried in slats by the cross-bearers and bolsters, and while the doors are closed, by chains attached to the shafts; the latter are automatically moved underneath the doors when they are fully closed, and the load is thus securely supported and accidental discharge is impossible.

The general dimensions of these cars, which were designed and constructed by the Pressed Steel Car Company, are as follows:

Length over end sills	42 ft. 9 ins.
Length inside of body	41 ft. 9 ins.
Width over stakes	10 ft. 2 ins.
Width inside	9 ft. 6¾ ins.
Depth of body to top of sides	4 ft. 4 ins.
Length of doors in clear	4 ft. 10 ins.
Width of doors in clear	4 ft. 2½ ins.



STANDARD ATLANTIC TYPE LOCOMOTIVE—HARRIMAN LINES.

Height of floor from top of rail.....4 ft. 5 ins.
Truck centres.....31 ft. 0 ins.

STANDARD ATLANTIC TYPE LOCOMOTIVE.

HARRIMAN LINES.

In the March number of this journal we illustrated a Pacific type locomotive, which was constructed on the standard design adopted by the Harriman Lines last year, which were completely illustrated in the AMERICAN ENGINEER, 1905, pages 154, 200, 250, 288, 320, 353, 400 and 441.

The illustration herewith shows the corresponding Atlantic type, an order of which has recently been constructed by the Baldwin Locomotive Works for the Southern Pacific Company. Locomotives of similar type, but equipped for burning coal, have also been built for the Union Pacific system and the Chicago & Alton.

The engine here shown is an oil burner and has 20x28-in. cylinders, 81-in. drivers and 200 lbs. steam pressure. The weight on driving wheels of 105,000 lbs. bears a ratio of 4.46 to the tractive effort, which is 23,500 lbs.

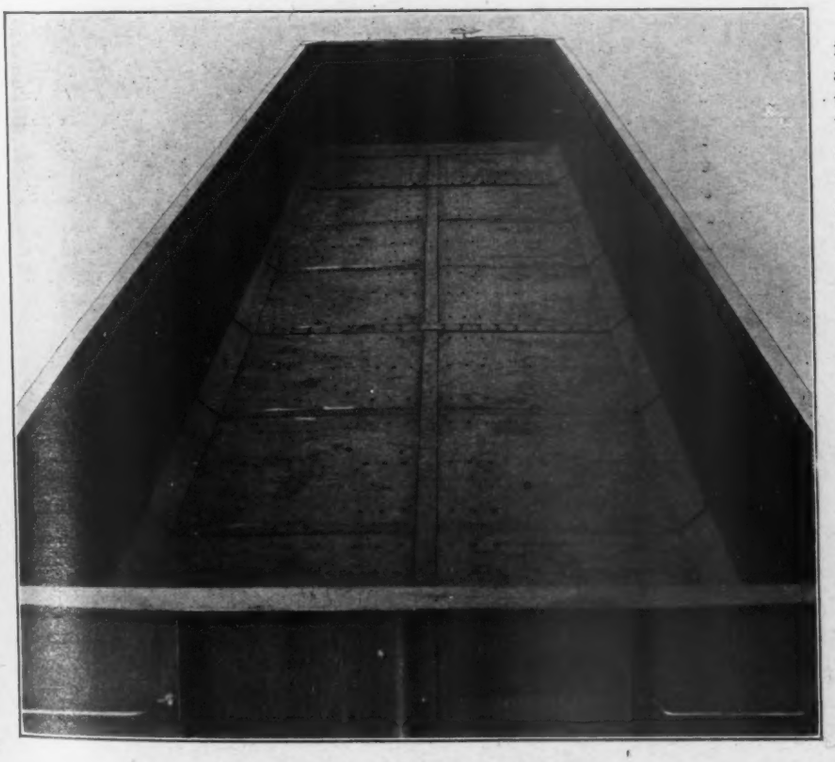
The boiler has a straight top and the tubes are spaced with ⅞-in. bridges. The mud ring is 5 ins. wide on all sides. The firebox is provided with a shallow ash pan and the oil burner is placed in the front end of the box.

The cylinders are fitted with a modification of the Sheedy circulating valve, the seat for which is located in the cylinder casting. The piston valves are 12 ins. in diameter and are driven by indirect link motion.

The frame has double front rails and has the main and trailing section in one piece. The trailing rigging is rigid and gives a rigid wheel base of 15 ft. 9 ins. to these engines, the driving wheel base being but 7 ft.

An unusually large tank has been applied, which is arranged with a water bottom and carries 9,000 gallons of water. The oil supply is carried in a separate tank located in the fuel space, and has a capacity of 2,835 gallons of oil.

The general dimensions, weights, ratios and side elevation of these engines will be found in the AMERICAN ENGINEER, 1905, pages 154 and 155.



GONDOLA CAR WITH DROP DOORS CLOSED.

GRINDING HIGH-SPEED TOOLS.—For grinding high-speed steel nothing is quite so good as a well-selected wet sandstone, and the tools ground thereon by hand pressure. Where such stones are either not obtainable or desired, and emery wheels are used, it is advisable to roughly grind the tools to shape *before* hardening, which grinding may be done mechanically. By so doing the tools require but little grinding after hardening (which may be done by hand), and only slight frictional heating occurs, so that the temper is not drawn in any way, or the cutting efficiency of the tool impaired. When the tools are ground on a wet emery wheel and undue pressure is applied, the heat generated by the great friction between the tool and the emery wheel causes the steel to become hot, and water playing on the steel whilst in this heated condition tends to produce cracking.—*Mr. J. M. Gledhill, before the Glasgow and West of Scotland Firemen, Engineers and Ironworkers' Association.*

COMPARATIVE SAFETY OF TRAVEL IN GREAT BRITAIN AND UNITED STATES.—There were carried on British railways during the year 1903 a total of 9,660,000,000 passengers one mile, and on American railways 20,915,000,000; the number of passengers killed being—in the United Kingdom 156, against 321 in the United States—indicating that the proportion of passengers killed to passengers carried one mile was one in 61,000,000 in Great Britain, and one to 65,000,000 passengers in the United States; which figures entirely controvert the impression conveyed by Dr. Sellenings' paper as regards comparative safety of travel in the two countries.—*Mr. W. G. Besler, New York Railroad Club.*

(Established 1832).

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*

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Mr. Jacob's address to college students, which is partially reproduced on another page, should be read by all those who are interested in the matter of shop production. It is not surprising that the engineering colleges have neglected to impress the students with the importance of the cost of production. It is only during the past few years that the manufacturing concerns have waked up to the importance of this problem, and apparently some of the railroad shop managements are still blissfully unaware of it. The successful shop manager is one who realizes the importance of studying the cost of production with a view to reducing it and increasing the shop output.

While walking through a large railroad shop where piece work is in force the power was shut off for a few minutes, due to a slight accident in the engine-room. The difference between a piece-work and a day-work shop was immediately apparent. The men, instead of lounging about or gathering in groups, started to oil up or adjust their machines and to arrange such work as might be lying on the floor, so that it could be handled with a minimum loss of time. The shop superintendent remarked that if anything interfered with the progress of the work, such as poorly or badly designed material, lack of material, poor light or inefficient tools, the men lost no time in notifying him. His time was not taken up by looking for weak spots, but rather to remedying the defects after they had been located.

It is comparatively easy to make a reputation in building very large locomotives. It is equally important, if more difficult, to make a reputation for the improvement of relatively light locomotives, which constitute the major part of the equipment of most railroads. It is in this direction that the superheater appears to offer at the present time its greatest advantage. Because it increases the capacity of the locomotive by improving its use of steam and because of its applicability to existing locomotives, the superheater appears opportunely, and if the good results now promised are obtained, the application to old locomotives is undoubtedly an advantage for this device. Thus far, superheating has proved a remarkable innovation, in that no serious or insurmountable difficulties have appeared. One feature of superheating, which is specially interesting in its application to old locomotives, has not yet received the attention which it merits. That is the possibility of reducing steam pressure without loss of power. This will lead to a great relief in boiler work.

During the year 1905 there appeared in this journal a very complete description of the standard locomotives to be used on the Harriman Lines. It will be remembered that the committee in that case released themselves from all bonds and adopted designs for all parts, which, after careful study, were decided to be the best possible design to be obtained at that time. These were to be used on all new power built after their adoption, and their application to the older engines already in use was a secondary consideration. In this issue appears the first part of an article descriptive of the standards recently adopted by the Canadian Pacific Railway for locomotive parts. In this case, while the designs are for use on all new power, and are up to date in every particular, primary attention has been given to their application to the locomotives already in service which are of comparatively recent design and will be in operation for many years to come. An examination of the table given will show that most gratifying results have been obtained; also that the standards have been carried much further than has heretofore been attempted, as, for example, the motion work and cylinders.

Often a man who is selected as a foreman is picked out because of his exceptional qualities as a skilled workman, but he may be for this very reason unsuccessful. A skilled workman does not necessarily make a poor foreman, but neither does he necessarily make a good one. Probably the chances are in favor of one who is not exceptional as to workmanship. While this quality is desirable, it is not so much needed in foremanship as the ability to take a birdseye view of the work of others. A man is needed who can plan and execute, who can keep the continuity of the work in his mind and bring various factors together to fit accurately, both as to mechanical construction and as to time. He must be a manager, able to keep material supplied and to see that work upon which other work depends is done in its proper time. Of course, management of men is important, but there is danger of over-management. Men want to be treated as men, and neither nagged nor coddled, but helped by every proper means so that their work will go smoothly and fit in with that of others. None are so quick as the workman to see whether or not there is any lost motion in their efforts, and none are quicker to see whether or not their efforts contribute directly to a smooth working plan which brings results by the shortest path. A perfect mechanic is more likely to watch only one part and to forget the necessity for management. Perhaps a laborer will be the better material than the skilled mechanic, but, of course, there are many steps between these positions. To make the selection, a thorough knowledge of every man is necessary, and in a large plant this is of course difficult. With the increase in size of an organization, it is becoming increasingly difficult to know the men individually, and at the same time it is becoming more and more necessary that some one should know them. The best preparation for selecting a foreman is a thorough knowledge of all the men, their capabilities and their possibilities.

One of the reports presented to the Master Mechanics' Association last year, which merits special attention, is that of the committee on time service of locomotives. This was printed in our August number, page 312. In this report a careful record of the service of a freight locomotive for a month, showed that the total time the locomotive was in the

hands of the motive power department was 22.6 per cent., the total time in the hands of the transportation department 46.8 per cent., and the proportion of the time when actually running was 28.7 per cent. These figures should not be used in comparing the departments and their relative responsibilities in the matter of the operation of locomotives, so much as to show the very great importance of the intimate association of the two departments and the necessity for the personal co-operation of the officers of both in the interest of the road as a whole. Undoubtedly, there is a great deal of dodging of responsibility in the matter of locomotive service. Cases are on record showing that transportation officers are not always careful to help the motive power men as much as possible in the ordering of locomotives for trains. Locomotives are too often ordered long before they are wanted, and the motive power department is continually traveling up-hill in order to meet requirements. There is no closer point of contact between the transportation and the motive power department than in the matter of locomotive service, and herein lies an opportunity for a development of good feeling and cordial co-operation, which does not appear as often as it should. One way to help matters along is to adopt a combination record blank for the roundhouse and the yard, showing all movements of the engines and giving the time of each, including the time locomotives are ordered for trains. Such information blanks have been adopted by several roads with very great advantage, and they have shown conclusively that locomotive movements at terminals can be greatly accelerated by the co-operation of the departments, exerted with a view of mutual helpfulness in every case.

MALLET COMPOUNDS FOR ROAD SERVICE.

For very large locomotive units required for handling heavy trains over steep grades which necessitate a pushing service, the advantages of the Mallet articulated type appear to be obvious in the experience of the Baltimore & Ohio Railroad with a locomotive of this type, which was described in this journal in June, 1904, page 237. That the Mallet articulated compound possesses perhaps equal advantages for heavy road service is not so generally understood, yet this seems to be the fact, for the following reasons:

With a Mallet articulated compound about 50 per cent. more load can be hauled than can be handled by the usual type of simple locomotive with its weight on four driving axles, allowing the same weight per axle. About 50 per cent. additional load can be hauled by a Mallet compound in heavy work without increasing the fuel consumption beyond the amount required by the simple locomotive. Stated on a ton mile basis, this amounts to a saving of about one-third in fuel. To accomplish this result only one crew is necessary.

Aside from the higher total tractive power of the Mallet compound, a higher tractive power related to the weight per axle can be obtained because of the conditions under which the two engines of the Mallet compound operate. This is because, in starting, the high cylinder pressures which cause slipping do not occur at the same time in the high and low pressure engines. If one engine slips, it reduces its own working pressure and takes its grip on the rail again automatically without the necessity of throttling. While the first engine slips the second engine gains in power and prevents a cessation of the drawbar pull, which may, in an ordinary engine, cause the stalling of the train if it occurs at a critical time. One notable feature in the operation of the Baltimore & Ohio Mallet compound is that in starting the train the drawbar pull is partially maintained in case either engine slips.

In this type of locomotive the entire weight is utilized for tractive purposes, and complications of trucks are avoided. This saving of complication is partially balanced by increasing the number of working parts, but in so doing a material gain in efficiency is secured.

In a very powerful locomotive, requiring eight or more driving wheels, the curve resistance is an item of moment. The Mallet compound offers a shorter, rigid wheel base, and must necessarily be less severe in its effect upon the track and must consequently lose less power in moving itself. With the compound applied according to this principle, a reserve starting capacity is available by the use of direct steam in all four cylinders, which means an advantage of about 20 per cent. of the normal power of the locomotive. In starting heavy loads and working on critical grades this feature of the compound locomotive is exceedingly valuable.

The Mallet compound has been criticized because of its complication. As a machine, it is undoubtedly complicated, but the division of the work of the enormous locomotive into two separate engines is unquestionably a step in the right direction, having in view the fact that main rods, crank pins and other working parts must be excessively large when made to withstand the stresses necessarily imposed upon them in very large locomotives of ordinary type.

The Mallet compound type therefore merits thoughtful consideration for general road service which requires locomotives of say 200,000 to 250,000 pounds total weight.

THE RAILROAD MECHANICAL ENGINEER.

A correspondent who has just taken a position as mechanical engineer on a good sized railroad, recently consulted the editor of this journal as to the duties of such a position. This gave the editor a chance to air his views for the benefit of the young man, and thinking that they may also be suggestive to others the reply to the correspondent's letter is herewith presented.

The mechanical engineer should have a strong grasp of the power problem, knowing exactly what the locomotives are doing and should be prepared to say what locomotives should be purchased when the next opportunity presents itself for increasing the power. He should keep an exceedingly close watch of engine failures, and by aid of his drafting room study the details and improve them so that they do not break down. He should keep close watch of locomotive statistics, knowing which locomotives cost the most to repair per ton mile, and he can give exceedingly valuable assistance to the operating officials in connection with tonnage rating of locomotives, in order to get the proper work out of them. By a careful study of the roundhouse problem on his road he should be prepared to suggest ways in which a little money may be spent in such a manner as to help the operating department out of many of its difficulties, particularly in severe winter weather. There are many things which he should do in connection with the operation of locomotives, studying the grates, fireboxes, front ends and the adjustment of the engines so that they will steam freely, thus giving valuable assistance to the motive power and other departments. A mechanical engineer generally confines his attention to the theoretical parts of the work and spends a great deal of his time in the drafting room, which is all right as far as it goes. Such an official should make such a study of the conditions as to enable him to get more out of the locomotive, and thus assist the motive power department to more freely meet the problem of the operating department. To do this it is necessary to understand the roundhouse, the shop, the handling of locomotives on the road, the fuel and its use and many other things. The whole matter of mechanical engineer's duties might be summed up by saying that such an official ought to be, in fact, if not in name, assistant superintendent of motive power, drawing to himself many lines which now diverge and are lost because of the lack of attention, which is due to the great pressure of details crowding upon the superintendent of motive power.

The post of mechanical engineer of a large railroad constitutes one of the rarest opportunities available to men who are mechanically inclined. The post is not always appreciated. The position is not what it should be, but it shares with many other positions in affording an opportunity for hard, conscientious work to be very effective in making a

reputation, acquiring acquaintance, and establishing a position which is really indispensible. The position is often a discouraging one because it does not usually involve the management of large numbers of men, and a mechanical engineer is usually quite a little out of touch with the most vexing and most weighty questions which require the instant, unerring decisions which make men great. That the mechanical engineer is in a position to advance to take the other highest responsibilities both in administration and in organization does not seem to be appreciated. This post offers the very best opportunities for preparation for the highest responsibilities of the motive power department and that more mechanical engineers are not advanced to become heads of the departments is too often the fault of the mechanical engineers themselves.

It may be difficult for the mechanical engineer to see how he can make an impression upon his superiors. Each case presents its own problems, but in general it may be said that the mechanical engineer may in the long run make a very deep impression on the net earnings of the road, if he will give his attention to the power question and bring up his young assistants to look after the details. As to the possibility of showing executive ability and the instinct of management perhaps the mechanical engineer's position is not fully understood. In the matter of drafting-room work costs and results may be kept as carefully and as effectively as in the shops.

One large road, not by any mean the largest in the country, issued 15,000 blue prints last year, requiring about 8,000 yards of blue print paper, their cost being perhaps $900. This, however, is insignificant as compared with the hours of labor in that drawing-room, which amounted to about 45,000, which made the cost of each drawing, averaged between the large and the small, about $20. The mechanical engineer here deals with a labor problem involving costs which are by no means insignificant, and when each drawing costs $20 he should, for his own protection, see that every drawing fulfils its mission and tends toward a reduction of the total cost of the operation of the road.

Investigations of some of the very largest drafting-rooms in the country show that the draftsman who commands $125 per month turns out drawings at about one-third less per drawing than the poor draftsman who can command only $60 or $70 per month. The mechanical engineer by keeping close watch on his department should be able to make an impression upon his superiors with such an argument as this, and thus be able to strengthen himself with men of real value who will help him to place the mechanical engineer's office in a dominating position, because of its effectiveness in strengthening the motive power organization. The railroads by neglecting to make draftsmen are committing an error which amounts to a sin. Every railroad, and, in fact, every engineering establishment has, after all, the sort of draftsmen which it deserves.

The answer to this question requires pages and pages to properly cover the ground, but the whole matter may be summed up by remarking that the mechanical engineer may become the center from which pretty nearly everything in the way of improvements eminates. In these days of improvements of shops, shop equipment and shop methods a wonderful opportunity lies before the mechanical engineer. In these days of improvements, previously unheard of, in the locomotive itself an equally wide field is presented. The fact that the mechanical engineer is not to-day a dominating influence in railroad progress indicates that some one has failed to see the opportunity which should be very apparent to every one.

These paragraphs are intended as an encouragement. It is feared that they have drifted into rather a severe criticism. Believing that these remarks are justified in the hope of ultimately encouraging the reader by showing him the opening which lies before him they are sent on their mission.

FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The special tools and fixtures which are necessary to make the large frame and Bradley hammers, forging and bulldozing machines in our modern railroad shops a source of profit are usually developed by the local management. This is due to the fact that the design of locomotive and car details, as well as the shop equipment and conditions, varies greatly on different roads. The efficiency of the smith shop depends largely on the proper use of these machines, or, to be more specific, on the success which the foreman and his assistants may have in devising special tools and dies for making the different parts, many of which are of intricate design.

This subject has been very closely followed up at the Collinwood shops of the Lake Shore & Michigan Southern Railway, and a special tool department has been organized for the manufacture of dies for special forgings made in bolt headers, forging machines and bulldozers. This department is located near the forging machines, so that the blacksmith shop foreman can keep in close touch with the development of the tools and confer with the die maker without leaving his immediate territory. The result has been very satisfactory, and we are fortunate in being able to present photographs of some of the articles which are being made in this shop. Except where otherwise mentioned, these parts are made on a 3½-in. Ajax forging machine. The credit for the very successful results which have been gained is largely due to the efforts of the blacksmith foreman and his assistant. The number of forgings which can be turned out in a given time, in most cases, depends entirely upon the heating facilities. Most of the forgings are finished by two or three strokes of the machine, and the output where furnaces of sufficient capacity are provided is remarkable.

No. 1 is a truss rod anchor—a very difficult forging to make, owing to the peculiar construction of the socket for the rod, the jaws being tied together by a web extending well forward. This forging is made complete in two operations from 1½ by 3½-in. commercial bar iron, the first operation forming the jaw complete, and the second forming the offset and shoulder. No. 2 is the end of a shaft crank. Two operations are required; the boss is formed in the first and the square hole is punched and finished in the second. No. 3 shows a plain upset easily formed in one operation. It is made in large quantities, and, while simple, would consume considerable time under the hammer. No. 4 is a hinge, each part of which is formed in one operation.

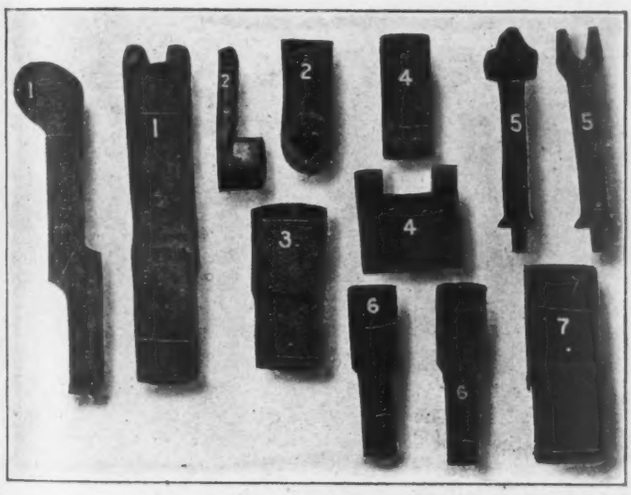
No. 5 is a truss rod column post. The receptacle for the truss rod is first formed, the rod is then pinched to form the pin, and the collar is formed in the third or last operation. No. 6, a grate shaker bar, is a specially difficult forging to make. As will be noted, the wrench is shown in full on the left and in section on the right. A band of iron, similar to a spring band, is first formed in special dies under a Bradley hammer. This part is then placed loosely on the bar, is heated in an oil furnace and welded and formed in one operation in the forging machine. No. 7 shows a simple upset and flange. Nos. 8 and 11 show two views of a toggle for a mail car which is made in two operations. This piece is punched from stock in the forging machine, and is then bossed and finished in a suitable die under a steam hammer. This forging could be made complete in a 5-in. Ajax forging machine.

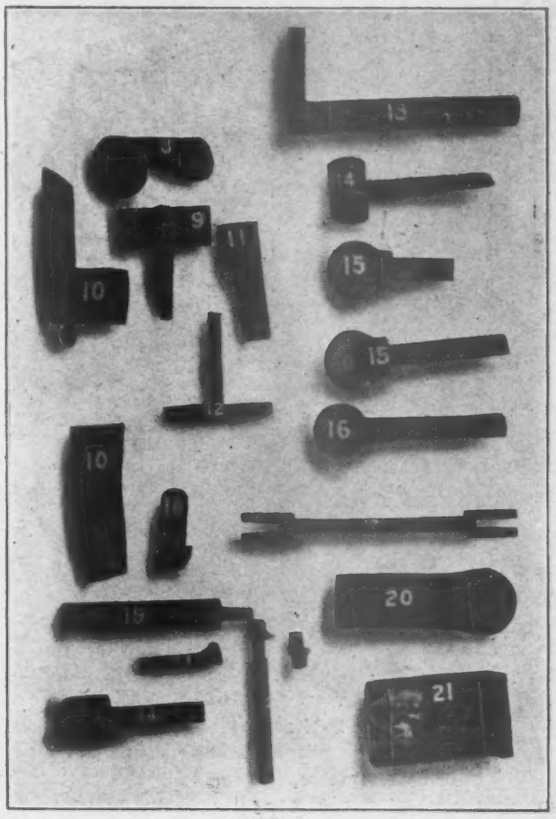
Nos. 9, 10 and 12 are carline ends for baggage, mail and caboose cars which may be cheaply formed in the forging machine. Nos. 9 and 12 are formed by bending a piece of flat stock in the shape of a U. This is placed loosely on the end of the bar, heated to a welding heat, and the foot is formed in one operation. With No. 10 a square hole is punched in the stock and the foot is sheared from the bar to leave a square end. This square pin is placed in the hole, both pieces are heated to a welding heat and the foot is formed in one operation. Nos. 13 to 19 are simple operations, with the ex-

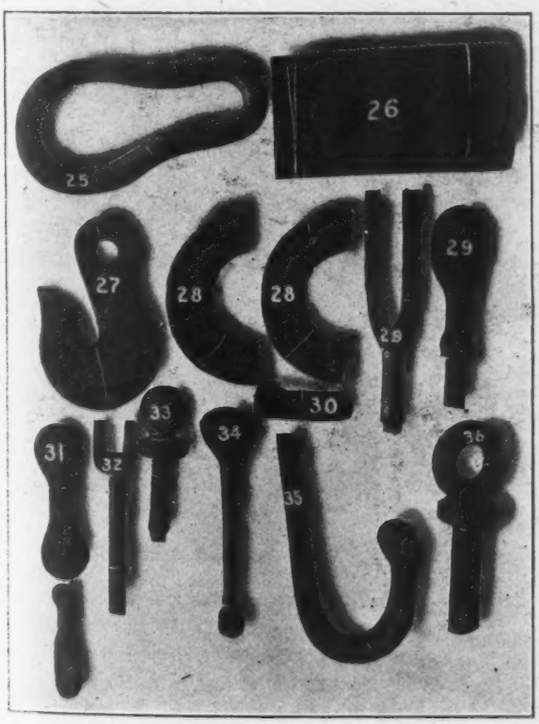
ception of No. 14, which might be puzzling to one not thoroughly acquainted with this class of work. It is formed in one operation from ½ by 2-in. flat stock with a boss 2 ins. in diameter and 3 ins. long.

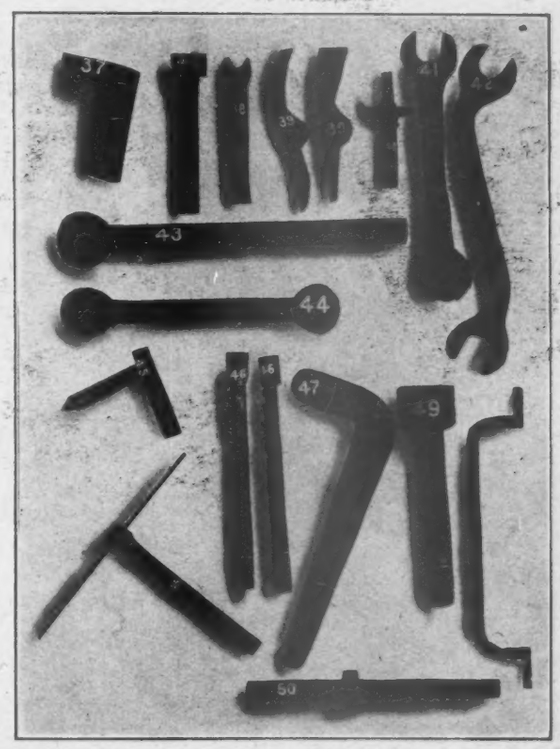
No. 20 shows the end of a spring hanger for heavy freight and passenger engines. The bar is cut to the proper length, both ends are upset, and it is then bent to the proper shape on a bulldozer. No. 21, the end of a coupler pocket, is punched, flanged, and the flange sheared to length in one stroke of the forging machine. The only objection to this is a slight stretching of the metal around the first hole, but this is being corrected by changing the dies to compress the flange. No. 22, a patch bolt, is formed and nicked on the end of the bar in one operation. Nos. 23 and 24 are also made in one operation.

No. 25, a link for a wrecking chain, is first bent to shape on a bulldozer, so that the ends overlap on the small end. These are then sheared to form a scarf, and are welded in special dies under a Bradley hammer, the entire link being









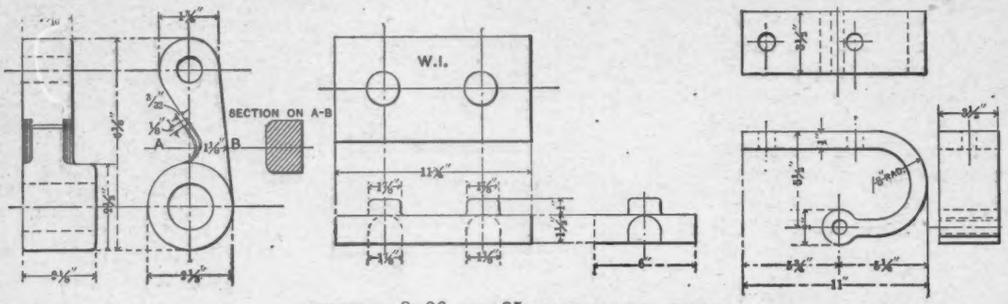
FORGINGS MADE AT THE COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

completed in three operations. No. 26, a double follower plate with solid bosses, is formed in one operation on a bulldozer. The bosses are formed by two ball-faced punches forcing the metal into large dies and leaving the walls of sufficient thickness for the required strength. This form is cheap and much more satisfactory than where the lugs are riveted to the plate. No. 27, a hook for wrecking chains, is punched, formed, straightened, the hole punched and countersunk in two operations. No. 28, a center plate bearing, is made from a rectangular plate in one operation. No. 29, a brake rod fork, is punched from scrap, usually old transoms, in a bulldozer. It is then welded and drawn out under a Bradley hammer.

No. 30, a split key, is bent and trimmed in a bulldozer in two operations. No. 31, a crown bar link, is punched from a flat bar in one operation. This design gives uniform strength and

maximum clearance. No. 32, a bell clapper fork, is made in two operations. Nos. 33, 34 and 36 are made under the hammer. No. 35 is a spring hanger, the boss being formed in one operation in the forging machine. It is then bent in a bulldozer. Nos. 37 and 38 are made in one operation each. No. 39, a ratchet and pawl, is made in two operations. It is first punched from steel stock in a forging machine and is then flattened, bent and cut to the proper angle under a Bradley hammer.

No. 40, a steel relief valve, is formed in the forging machine from round stock in two operations. Nos. 41 and 42



FORGINGS 8, 26 AND 35—COLLINWOOD SHOPS.

show the various steps in manufacturing a wrench. No. 42 represents a finished ¾ and ⅞-in. wrench for car repairers. After much careful study a set of dies were constructed for making one end of the wrench complete in a forging machine from 1-in. round steel in three operations. The center is then finished in special dies under a Bradley hammer. The wrench comes from the machine finished, requiring no dressing. No. 43, a standard wedge bolt, is made from 1¼-in. stock. No. 44 is a spring hanger, each end of which is formed in one operation.

No. 45 is a cheap and very satisfactory ash hoe. A 1⅛-in. oval hole is first punched in the plate. The rod is then heated, and one stroke of the machine forms a head on each side of the plate and also compresses the metal into the oval hole, preventing the bolt from turning in case the heads should loosen in service. No. 46, a socket wrench, is made in one operation. No. 47 is similar to No. 14. The boss is formed in one operation, and the shank is then bent and formed in one operation in a bulldozer. No. 48 is a grab handle. The foot is formed, punched, and the rod is bent with one heating and one handling for each end and straightened ready for application. No. 49 is made in one operation. No. 50, a collar wedge bolt, is formed and squared in two operations.

In addition to the above a number of cast iron formers are used in connection with the bulldozer for the cold and hot bending of arch bars, transoms, grate side bars, etc. A jib crane with a chain hoist serves to transfer the formers to and from the machine. We are indebted for photographs and information to Mr. M. D. Franey, superintendent of the Collinwood shops.

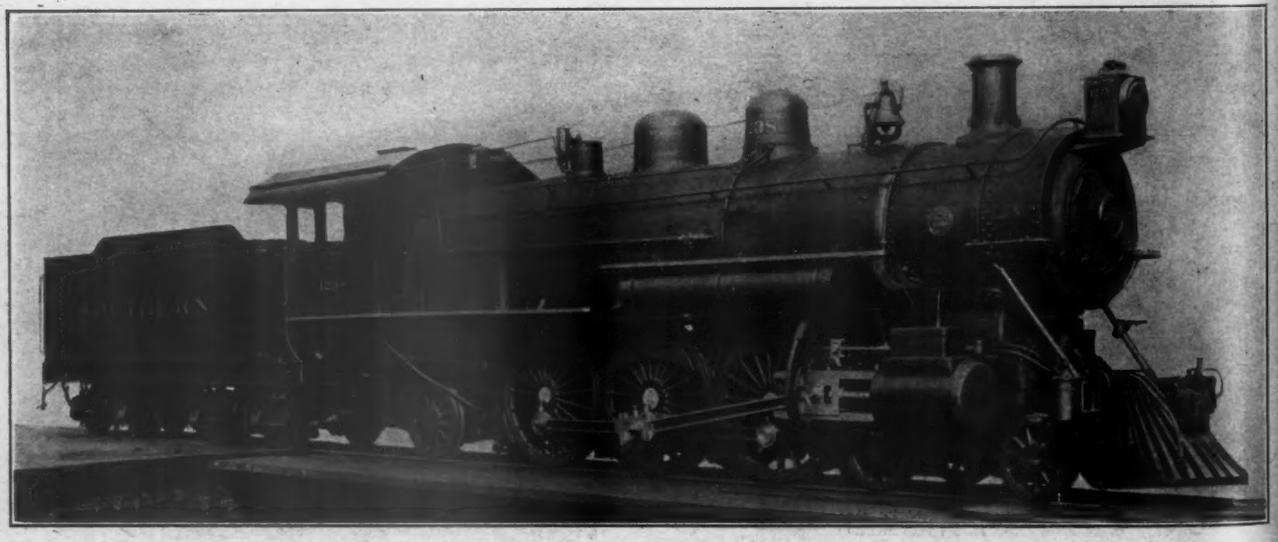
PACIFIC TYPE PASSENGER LOCOMOTIVE.

SOUTHERN RAILWAY.

The Baldwin Locomotive Works has recently delivered an order of 20 very powerful Pacific type locomotives to the South-Railway. Fifteen of these engines have 63-in. drivers and the the remaining five 72½-in. drivers, otherwise the design being very similar. The illustrations herewith apply to the latter class.

The cylinders, which are single expansion, are 22 ins. diameter by 28-in. stroke, which, taken in connection with the steam pressure of 220 lbs. and driving wheels of 72½ ins., gives a tractive effort of nearly 35,000 lbs. In this they are the most powerful engines of this type of which we have a record. The weight on drivers is 138,460 lbs., giving a factor of adhesion of 3.97. The ratio of total weight to tractive effort is 6.31, the weight on drivers being 62½ per cent. of the total weight.

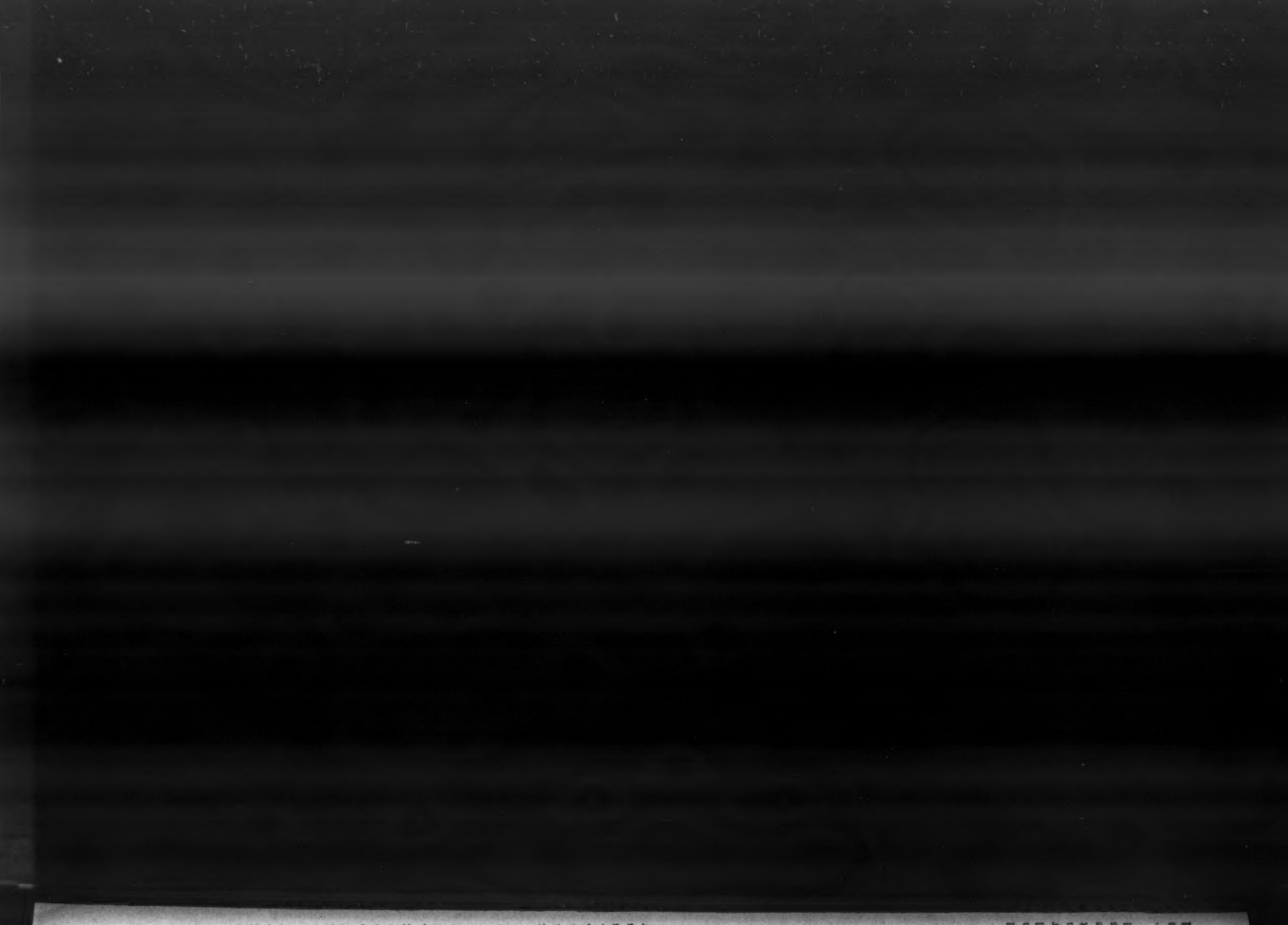
The boiler is of the straight top type with sloping throat and back head. The firebox is radial stayed. The longitudinal seams in the boiler are butt jointed and are welded at each end. The flues, of which there are 314—2¼ ins. in diameter, are 20 ft. long and give a heating surface of 3,683.5 sq. ft. The boiler is liberally supplied with washout plugs and has ⅜-in. liners in the waist over the supporting guide bearers and waist sheets. The check valve is located somewhat further back from the front flue sheet than has been customary.

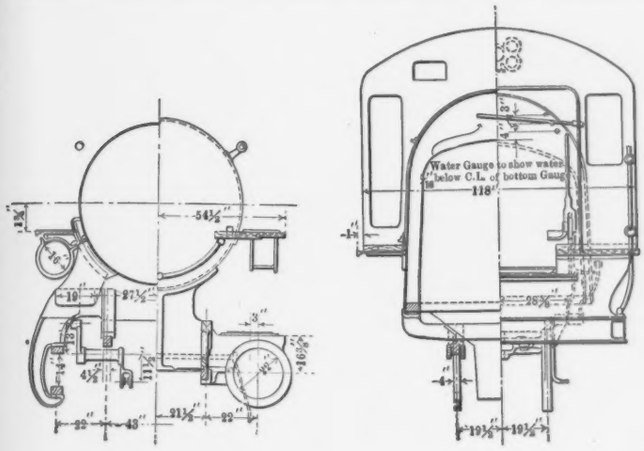


PACIFIC TYPE PASSENGER LOCOMOTIVE—SOUTHERN RAILWAY.

Slide valves are used and the rocker arm, which is placed forward of the front drivers, operates the valve stem through a cross-head connection. The frames are of cast-steel and have double front rails spanning the cylinders. The rear sections are separate from the main frames and connect with a splice at the front end of the firebox, which is supported at this point by a vertical plate. The trailer truck is of the Rushton type and is equalized with the drivers. The cab is placed somewhat further back than usual, giving a fair-sized deck.

In the matter of details these engines present nothing particularly novel, employing such parts as long practice has proven to be satisfactory. The general dimensions, weights and

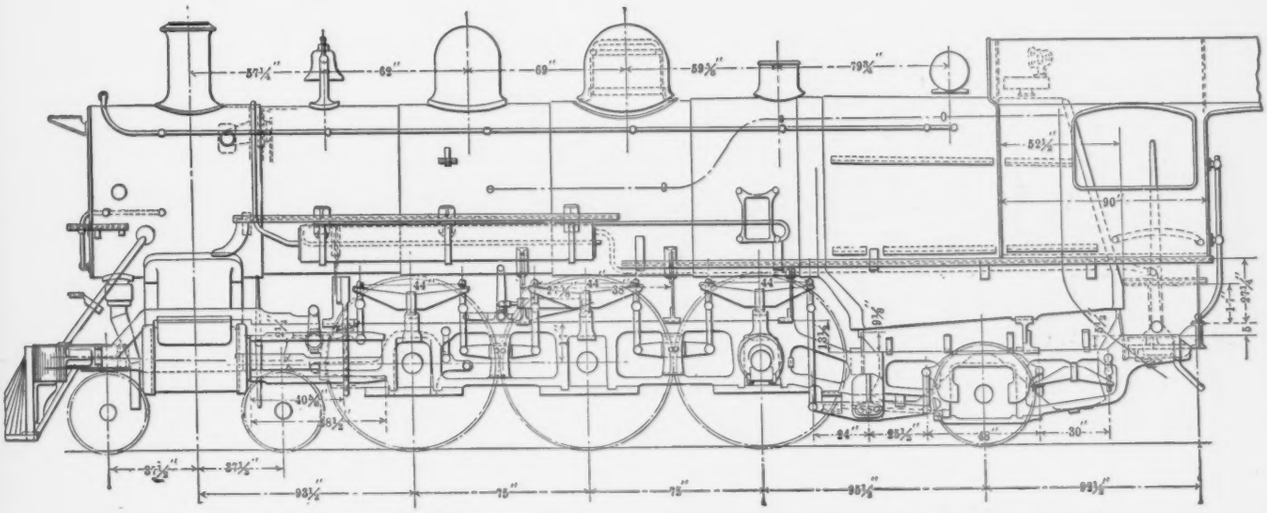




CONVENIENT TOOL BOX FOR ROUNDHOUSES.

This engraving illustrates a portable tool box which is used to very good advantage in the shops and roundhouses of the Lake Shore & Michigan Southern Railway at Elkhart, Ind. The box is built upon a two-wheel truck, the axle and wheels of which are placed in such a position that the box itself may stand upon end upon the floor, or it may be used in a horizontal position for the men to stand upon in working about the locomotives. The engraving requires no further description. Where they are used a great deal of blocking and horses or trestles are avoided in the shops. We are indebted to Mr. C. W. Cross, former master mechanic, for the drawing.

LARGEST TONNAGE PER HOUR.—For slow freight service, where a greater tractive power is desired than what can be obtained from a properly designed Consolidation type locomotive, it would appear that the use of the Mallet articulated design, as already described, would result in the movement of the greatest tonnage per hour over a single piece of level or mountainous track, with a proper degree of safety, efficiency and economy.—*Mr. Muhlfeld, New York Railroad Club.*



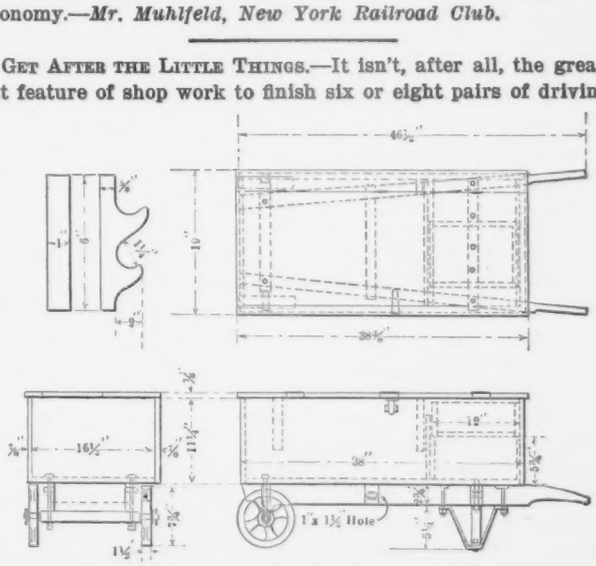
ELEVATION AND SECTION, PACIFIC TYPE LOCOMOTIVE—SOUTHERN RAILWAY.

ratios given below, together with the side elevation and general view shown herewith, will illustrate the principal features of these very powerful locomotives:

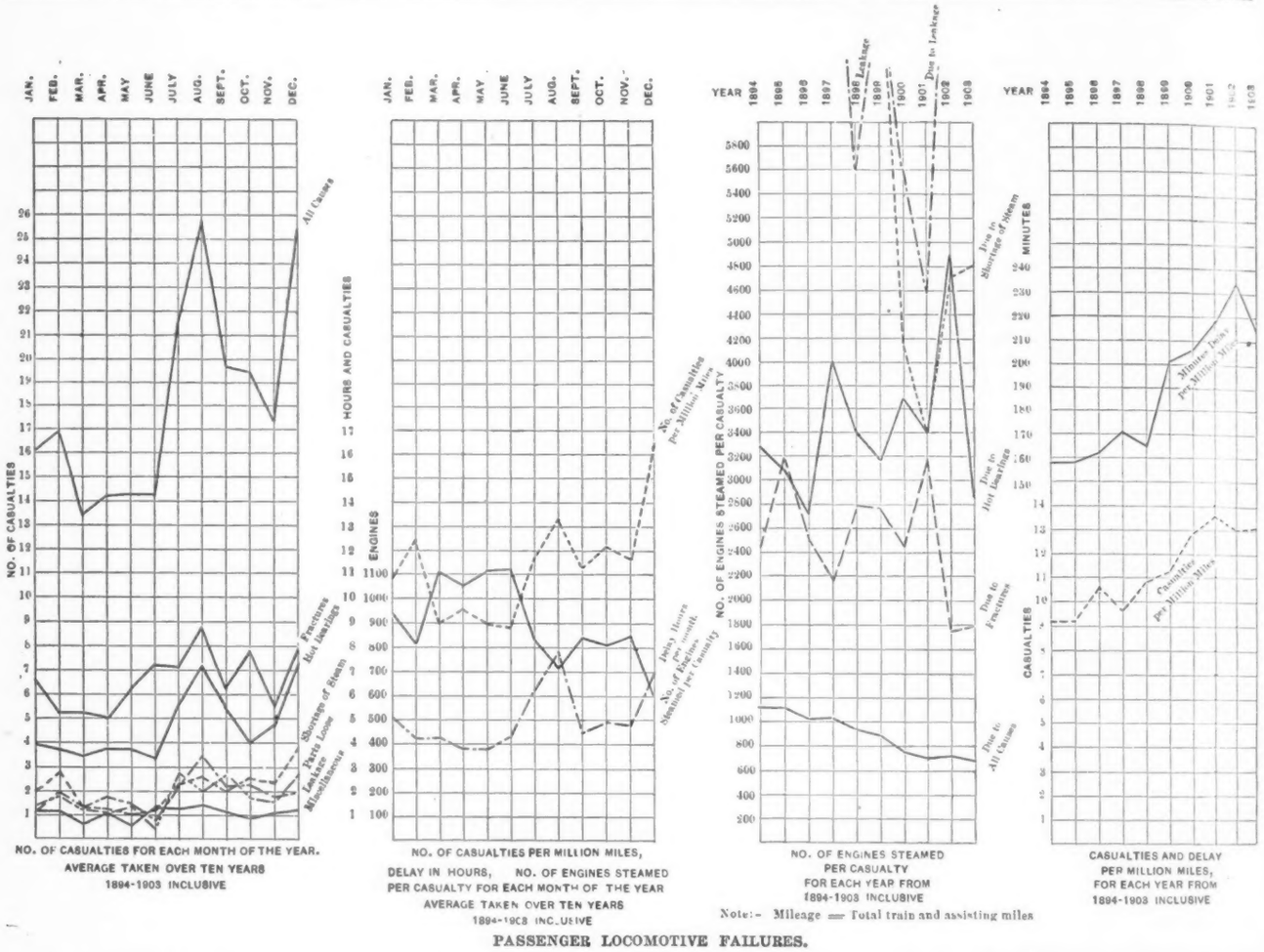
SIMPLE PACIFIC TYPE PASSENGER LOCOMOTIVE, SOUTHERN RY.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger.
Fuel	Bituminous coal.
Tractive Power	34,940 lbs.
Weight in working order	220,500 lbs.
Weight on drivers	138,460 lbs.
Weight on leading truck	39,700 lbs.
Weight on trailing truck	42,300 lbs.
Weight of engine and tender in working order	358,000 lbs.
Wheel base, driving	12 ft. 6 ins.
Wheel base, total	31 ft. 4½ ins.
Wheel base, engine and tender	64 ft. 5⅞ ins.
RATIOS.	
Tractive weight ÷ tractive effort	3.97
Tractive effort x diam. drivers ÷ heating surface	653
Heating surface ÷ grate area	71.5
Total weight ÷ tractive effort	6.31
CYLINDERS.	
Diameter and stroke	22 by 28 ins.
Valves	Balanced slide.
WHEELS.	
Driving, diameter over tires	72½ ins.
Driving, thickness of tires	3¼ ins.
Driving journals, main, diameter and length	10x12 ins.
Driving journals, others, diameter and length	9x12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	5½x10 ins.
Trailing truck wheels, diameter	42 ins.
Trailing truck, journals	8x12 ins.
BOILER.	
Style	Straight.
Working pressure	220 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108⅛x72½ ins.
Firebox plates, thickness	⅝ and ½ in.
Firebox, water space	4½ and 3½ ins.
Tubes, number and outside diameter	314-2¼ ins.
Tubes, gauge and length	20 ft.
Heating surface, tubes	3,683.5 sq. ft.
Heating surface, firebox	195 sq. ft.
Heating surface, total	3,878.5 sq. ft.
Grate area	54.25 sq. ft.
TENDER.	
Wheels, diameter	33 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,500 gals.
Coal capacity	12½ tons.

GET AFTER THE LITTLE THINGS.—It isn't, after all, the greatest feature of shop work to finish six or eight pairs of driving wheels per day, but it is a money-making scheme to put the closest thought on the 200 or 300 other jobs which keep 25 other machines busy and which, because they are small, we pass by regularly as being unimportant. More money can be made for your company by following up the 100 small items than by putting the major thought on the ten large items.—*Mr. C. J. Crowley, Western Railway Club.*



PORTABLE TOOL BOX FOR ROUNDHOUSES.


JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
NO. OF CASUALTIES
All Causes
Fractures
Hot Bearings
Shortage of Steam
Parts Loose
Leakages
Miscellaneous
NO. OF CASUALTIES FOR EACH MONTH OF THE YEAR.
AVERAGE TAKEN OVER TEN YEARS
1894-1903 INCLUSIVE
HOURS AND CASUALTIES
ENGINES
No. of Casualties Per Million Miles
Delay Hours per month
No. of Engines Steamed per Casualty
NO. OF CASUALTIES PER MILLION MILES,
DELAY IN HOURS, NO. OF ENGINES STEAMED
PER CASUALTY FOR EACH MONTH OF THE YEAR
AVERAGE TAKEN OVER TEN YEARS
1894-1903 INCLUSIVE
YEAR 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903
1898 Leakage
1900 Leakage
1901 Leakage
NO. OF ENGINES STEAMED PER CASUALTY
Due to Shortage of Steam
Due to Hot Bearings
Due to Fractures
Due to All Causes
NO. OF ENGINES STEAMED
PER CASUALTY
FOR EACH YEAR FROM
1894-1903 INCLUSIVE
YEAR 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903
MINUTES
CASUALTIES
Minutes Delay Per Million Miles
Casualties Per Million Miles
CASUALTIES AND DELAY
PER MILLION MILES,
FOR EACH YEAR FROM
1894-1903 INCLUSIVE

Note:- Mileage = Total train and assisting miles

PASSENGER LOCOMOTIVE FAILURES.

A TEN YEARS' RECORD OF LOCOMOTIVE FAILURE.

Several references have been made in this journal to the care which is given to English locomotives and their consequent freedom from breakdowns. One of the English roads having somewhat less than 3,000 locomotives and a track mileage of about 2,500 miles, recently made a careful study of its locomotive casualties, as contained in the reports to the secretary covering a period of ten years and including locomotives in passenger and freight service, under separate headings. This unique study presents interesting information as a basis of a study of the changes in conditions of operation in England and American railway officials may see in it an example of the value of the care, in the matter of running repairs for which English railroads are noted.

The English term for locomotive failure is "casualty," and in these reports only those cases are included in which time has been lost by actual inability of the locomotive to perform its required task through some defect in itself or mismanagement on the part of the men in charge of it, or for any fault in which a locomotive department may be properly held accountable. In the passenger record each case is recorded when the net delay is three minutes or over, which is not made up. The freight record shows net delays of three minutes or over on the same basis. In this record the careful student will find that the number of cases in which trains had to be given up by the engine men to be a very large proportion, very much larger than is the case in this country. This seems to indicate the difference between our admittedly ineffective care of locomotives, which tends to allow many of them to get into a condition so as to pull their trains indifferently, and thus maintaining them more nearly on the ragged edge than is the case in England. About 60 per cent. of the breakdowns in this record are of such a character as to put the locomotive temporarily out of business. They were real breakdowns.

The records will be considered separately for passenger and for freight, and in each case a diagrammatic summary is presented, which speaks for itself.

PASSENGER SERVICE.

These records cover the years from 1894 to 1903 inclusive. They are grouped under the following heads:

1. Fracture or other failure of material. This includes burst tubes; breakage or distortion of any part or stripping the threads.

2. Hot bearings includes over heating of any working part by friction.

3. Shortage of steam includes everything due to a failure to maintain steam pressure.

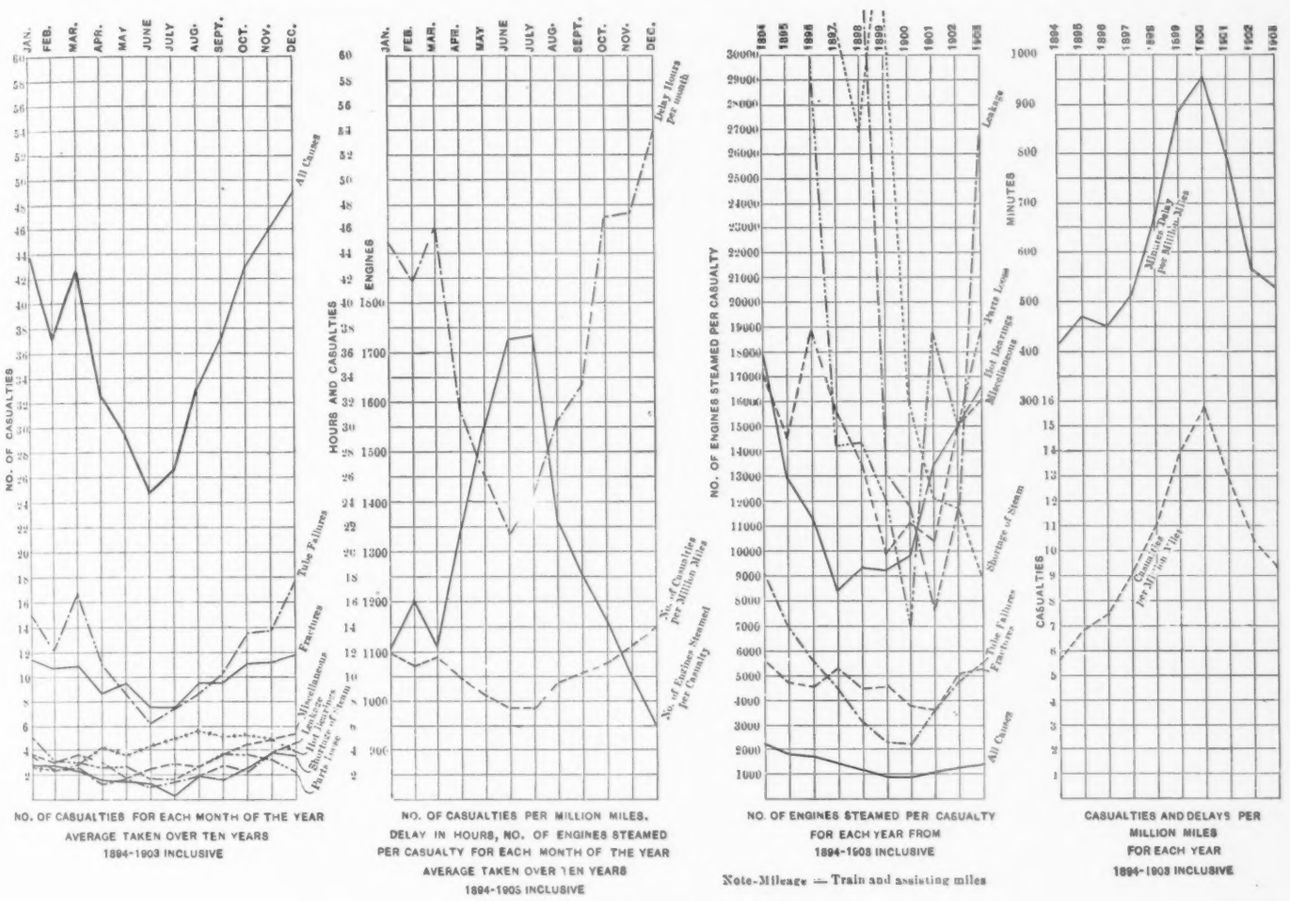
4. Leakage includes all cases of leakages of steam or water either from the boiler or the tank which cannot be included in any of the other groups, such as from riveted joints, slack tubes, loose manhole covers, packing, piston valves, water valves and all kinds of joints.

5. Parts becoming loose or detached includes all cases in which the casualty should be primarily attributed to any part becoming loose or detached, such as the falling of the brick arch, steam joints blown out; the pins or collars working out.

6. Miscellaneous cases include all cases which could not be clearly placed under any of the foregoing heads such as defective injectors, sanding apparatus or shortage of water.

The summary of the above classifications, with the exception of the shortage of steam, shows the following results: Under fracture or other failure of material there are 797 casualties during the ten years or 36 per cent. of the total. Hot bearings accounted for 568 casualties or 26 per cent. Shortage of steam 255 cases or 11.6 per cent. Leakage 230 cases or 10.4 per cent. Parts becoming loose or detached 217 cases or 9.5 per cent. Miscellaneous cases 135 or 6.2 per cent.

The total number of casualties for the ten years aggregated but 2,202 for the entire passenger service on one of the best



Note-Mileage = Train and assisting miles

FREIGHT LOCOMOTIVE FAILURES.

known railroads in England. The number of passenger locomotives concerned cannot be stated without violating the confidential understanding under which this record is presented.

During the ten years under survey the passenger engines were steamed 1,920,377 times. The total delay from casualties aggregated 610½ hours, an average of about 16 minutes delay per casualty, and one casualty for every 870 engines steamed. Imagine the passenger locomotives of an American railroad operating so that in ten years 870 engines would be steamed for one delay of three minutes which the engines could not make up!

Under fracture or other failure of material burst tubes accounts for 29 per cent. and valve gear failures for 12 per cent. Connecting rod ends account for over 66 per cent. and hotboxes for 23 per cent of all the hot bearings. Leaky tubes account for 80 per cent. of the leakage. The falling of brick arches accounts for 29 per cent. and the failure of damper rigging for 8 per cent. of all the parts becoming loose or detached. Failure of injectors or injector apparatus accounts for 50 per cent of the miscellaneous cases and half of these are due to check failures.

The average number of casualties in which trains were given up by the engine men amounted to 63.4 per cent. for the ten years or roughly two out of every three cases. The diagrammatic record shows the casualties for the ten years by years. From 1894 to 1903 the number of casualties has gradually increased not only in number, but the number has increased in proportion to the miles run and the number of engines steamed.

Shortage of steam became serious in 1900 and was at its worst in 1901. Comparing the years 1894 and 1903, and considering casualties due to all causes there were 37 per cent. fewer engines steamed per casualty, and 35 per cent more time lost per million miles and 41 per cent. more casualties per million miles in 1903 than in 1894. This suggests a decreased efficiency, which has been gradual throughout the ten years for which, no doubt, there are many contributary causes, such as increased steam pressure, higher speeds, longer runs and more exacting conditions under which trains are now worked.

In making up the synopsis it was found that 36 per cent. of the casualties could be considered accidental, 20 per cent. were due to wear and tear, while the engine men were to blame in only 12½ per cent. of the cases. This study revealed opportunities for improvement in design. The report from which these interesting figures were taken discusses suggested improvements, which will undoubtedly be reflected in the report for the next ten years.

FREIGHT SERVICE.

With the exception of keeping a separate record of casualties, due to burst and leaking tubes, the freight record followed the plans of the passenger record, with the same subdivisions. The diagrams in both cases show the fluctuations. There were 4,963 casualties in ten years, the number of engines steamed being 5,536,869 with an aggregate delay of 4,481¼ hours or one casualty per 1,245 engines steamed and an average delay of 60½ minutes per casualty. Trains were given up on 3,159 occasions or an average of 71 per cent., the record showing that during the last four years the casualties have apparently been of a less serious nature than formerly. Naturally, the highest number of casualties occurred during the winter, from October to March, and the fewest in May, June and July. Taking the years separately there was a gradual rise in the number of casualties per million miles from 1894 to 1900, but since that year the figures have steadily improved, the year 1903 being slightly better than the average for the whole of the ten years.

A summary of the causes shows a total of 1,204 casualties

or 27 per cent due to fracture or other failure of material. Burst or leaking tubes accounted for 1,420 or 32 per cent. Hot bearings 491 cases or 11 per cent. Shortage of steam 264 cases or 5.9 per cent. Leakage 297 cases or 6.7 per cent. Parts becoming loose or detached 371 cases or 8.1 per cent. Miscellaneous cases 416 or 9.3 per cent. The accidental causes number 1,274 and wear and tear accounted for 1,630. Engine men were found to be at fault in only 381 cases. There were 142 cases of flaws in material and 220 cases of other flaws which were hidden.

Some of these figures are difficult to credit, except through knowledge that English locomotives are, as a rule, operated well within their limits of capacity, the very life not being pounded out of them as it is in some other countries which could be mentioned. There is a lesson in this investigation entirely aside from those to be learned from the reports themselves; viz., that a study of this kind is a most valuable check upon engineering as applied to the locomotive. If an English locomotive is in bad order it is held in the engine-house and fixed, its place being taken by one that is in proper order. English train service could not be handled in any other way. American railroad officials should make a study of this record as a preparation for similar study of their own practice.

POWER REQUIRED BY MACHINE TOOLS, WITH SPECIAL REFERENCE TO INDIVIDUAL MOTOR DRIVE.

By G. M. Campbell.*

(*Continued from Page* 108).

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take, this is the reciprocating tool, as the shaper and planer and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives, where the motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a flywheel of large diameter and heavy rim so as to aid the motor at moment of reversal.

Fig. 6 is for a 60-in. by 60-in. by 20-ft. Pond planer. The cycle of power consumption is rather remarkable, but is a fair example of tools of this class and method of drive, reversal by shifting belts. These readings were taken with the machine running light. During cutting stroke the horse power taken was 3.9, reversing to return stroke the power jumped to 19; on the return stroke it was 6.3 and in reversing to cutting stroke it rose to 27.0. Speed of the table in cutting stroke about 25 ft. per minute; on the reverse stroke, 60 ft. per minute. This planer was driven by a compound wound Crocker-Wheeler motor 73.5 amperes, 20 h.p. at full speed and voltage rating. The flywheel on this machine is much too small, but, owing to special design of the driving mechanism, it could not be increased. The driving mechanism would have to be improved considerably to make it suitable for much higher speeds.

Fig. 7 is of some tests on a 36-in. by 36-in. by 12-ft. Pond planer on exhibition at St. Louis Exposition. This machine was driven by a reversing motor, belts being entirely done away with. The same general cycle is evident. Horse power, 4.1, to 18.0, to 6.0, to 24.0 and back to 4.1. Speed of table cutting stroke was 32 ft. per minute, return stroke 75 ft. per minute. The horse power in this curve includes the power losses in the motor itself which are not included in any of the other cases. This planer was driven by a No. 7, 6-h.p., type S, Westinghouse motor, speed range 4 to 1, rating 48 amperes at 110 or 220 volts. Loads obtained in taking heavy cuts were considerably in excess of the rating of the motor. In comparing the horse power rating of the motors on these two planers, the relative ratings given in Fig. 1 must be borne in mind; they are not rated on the same basis.

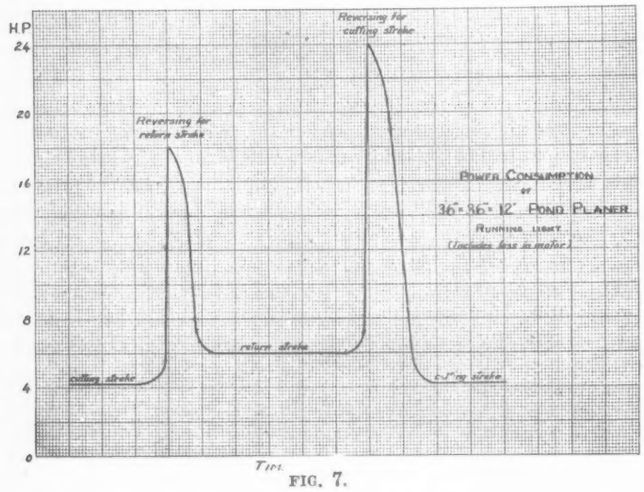


FIG. 7.

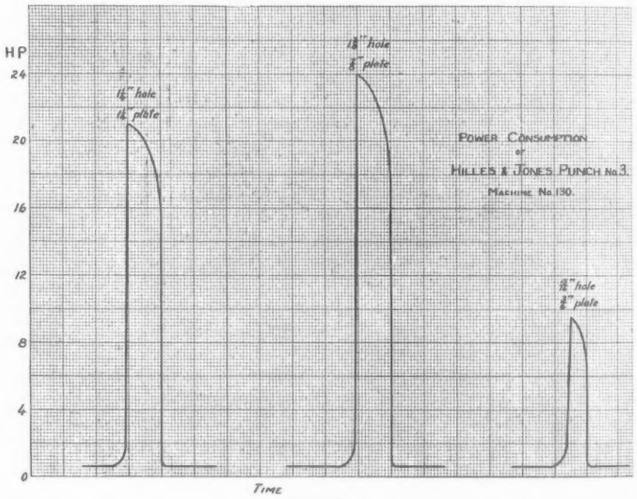


FIG. 8.

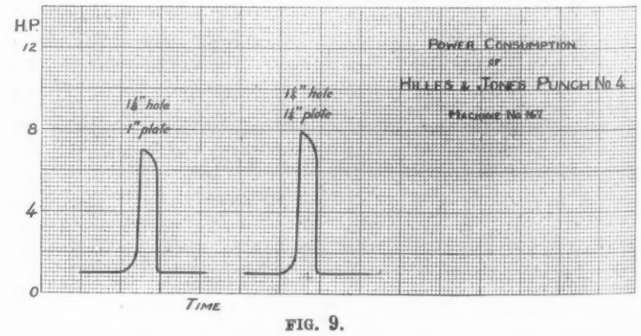


FIG. 9.

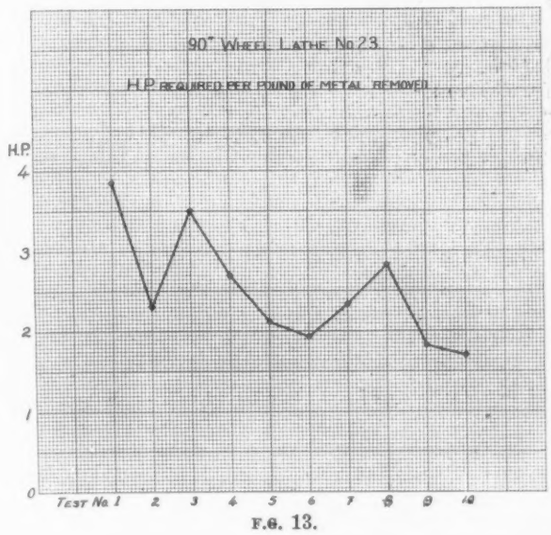
Influence of design on the power required for punches and shears is well brought out by Figs. 8 and 9; each machine was used, for example, for punching a 1¼-in. hole in a 1¼-in. plate. In the lighter machine, Fig. 8, the horse power rose to 21, while in Fig. 9, only to 7.9, showing very clearly the influence of the heavy flywheel and gear in the latter machine.

In the shops of the P. & L. E. R. R., at McKees Rocks, there are about 80 machines driven by individual motors. For vari-

*From a paper read before the Mechanical Section of the Engineers' Society of Western Pennsylvania.

able speed work, the speed variation required in the motor was, in general, about 2.8 to 1 for full power, but up to from 6 and 7½ to 1 for diminished power at low speeds, and the size of motor was approximately double the horse power required by the machine throughout this full power range, i. e., if the motor was rated as a variable speed motor, it would have a rating approximately one-half that of the constant speed rating. The speed variation in many instances differed considerably from the above. In many of the drills, the speed variation was higher and in planers, shapers, etc., lower. As has been brought out in previous papers read before this society, the speed control in these shops is obtained by means of the multi-voltage system. The horse power required by the machine was determined partly by general considerations and partly by the formula stated above, HP = KW, where K had a value of 3.6 for hard steels and 2.5 for soft steels. From data given on previous pages, it may be seen that the size of this constant was on the safe side. All machines are protected by both circuit breaker and fuses; the size of the breaker was, in general, 4 amperes per rated horse power of the motor and it was set at the limit of 50 per cent. above this rating, the breaker would therefore fly out when the power consumption was approximately 100 per cent. overload. On reciprocating tools, the circuit breaker was set 40 to 50 per cent. higher. The enclosed fuses used had a rating the same as that at which the circuit breakers were set.

After the plant was in operation a large number of tests were made, every machine listed being tested to see whether or not the motor capacity was sufficient. (For list of machines and motors see AMERICAN ENGINEER AND RAILROAD JOURNAL, page 341, September, 1904). In no case is the motor too small. In a few cases the motor could easily be reduced for P. & L. E. R. R. work; in general, the sizes are such as would be used providing the size of motors had to be fixed over again.



F.G. 13.

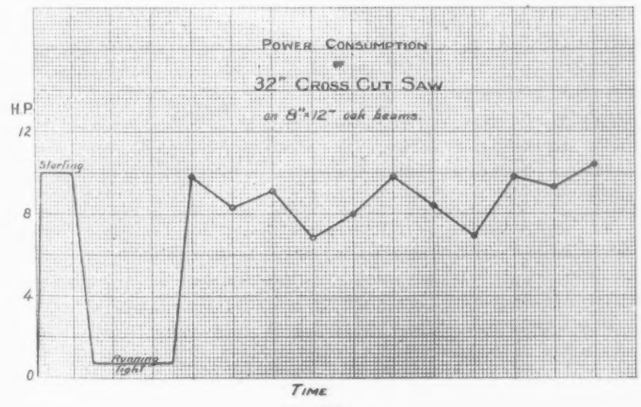


FIG. 16.

On a 90-in. driving wheel lathe, after eliminating the power lost in friction given in Fig. 4 and in the motor, practically the same as in Fig. 11, the horse power required to remove one pound of metal is given in Fig. 13; the amount varies from 3.87 to 1.70, certainly a very wide range, but the grade of steel also varies widely.

As to the power required by wood working tools, the writer has formulated no general rules, a few sample power readings will be given to show the power required in certain machines. The power consumption in wood working tools is very large, very much larger than one might ordinarily ex-

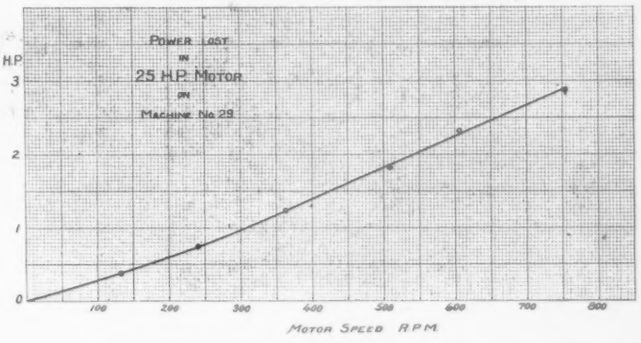


FIG. 11.

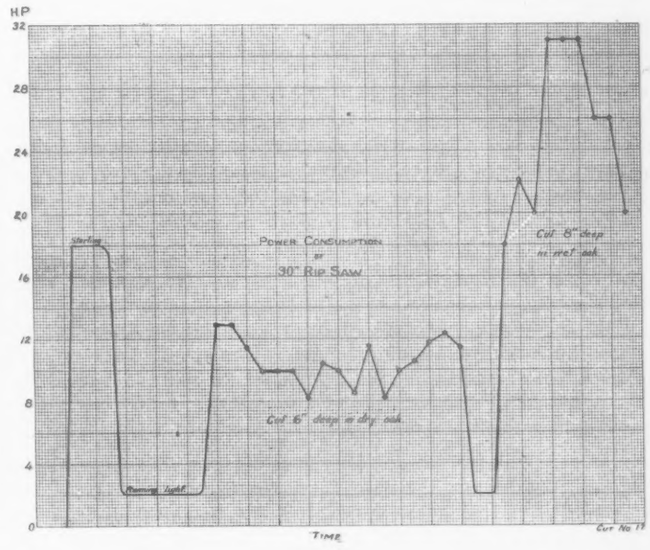


FIG. 17.

pect. In adapting these machines for motor drive, the motor should have ample capacity when the machine is to be used continuously in a manufacturing shop. Fig. 15 gives the power required to drive an 8 in. by 24-in. Fay planer reducing a 6½ to 6¾ in. by 12-in. and a 6¾ to 7 in. by 12-in. oak beam to 6 ins. by 12 ins. Power required starting machine was about 25 h.p., running light, 5.7 h.p. The power under cut includes the power loss running light. Readings were taken about 15 seconds apart. Fig. 16 is for a 32-in. cross cut saw, sawing 8 by 12-in. oak beams. Fig. 17 is for 30-in. rip saw, first part taking cut 6 ins. deep in dry oak, second part 8 ins. deep in very wet oak.

The total power lost in the motors and lost in friction in the machines is considerable, even though in individual cases it is not very large. To investigate this point, among others, some experiments were made on a Sunday when the shops were idle. Forty-six machines were selected, every one equipped with an individual motor capable of speed variation. The machines were as follows:

Machines.		Horse Power Rating of Motors.
17	Lathes	215
5	Milling Machines and Boring Mills	70
5	Planers	66
5	Slotters and Shapers	35

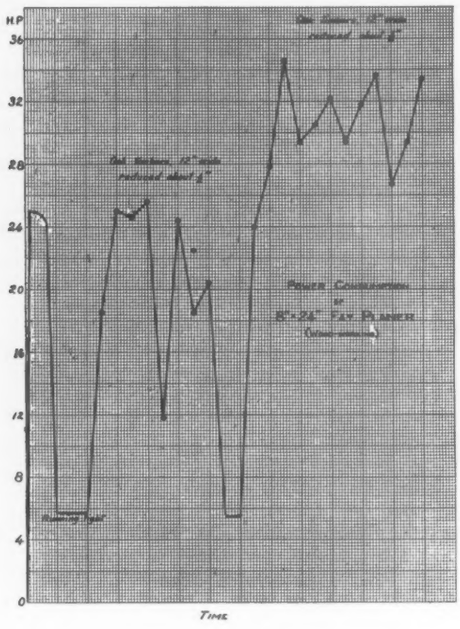


FIG. 15.

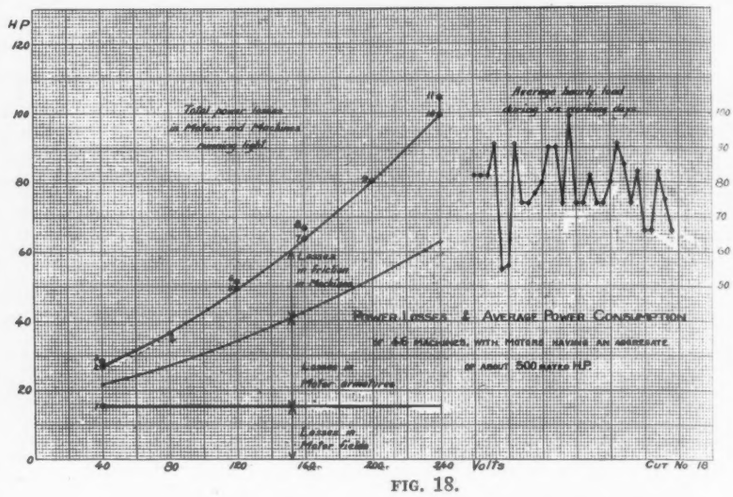


FIG. 18.

9	Drilling Machines	50
5	Punches, Shapers, Rolls, etc.....	61
46		497

First, full current strength was put on all the fields, then all the motors were run on the 40-volt circuit, then all on the 80-volt circuit, 120-volt, 160-volt, 200-volt and 240-volt in turn, and finally lathes and drills were run on the high-speed point, approximately 30 per cent. above normal 240-volt speed, power consumption being noted at all the different points. All machines driven by these motors were in motion, but no work was being done, nor was feed mechanism in use. The results are tabulated in Fig. 18; planer platens were not operating except for points 3, 6, and 8. The curve giving losses in motor armatures was plotted from readings on a number of motors disconnected from machines. The speed of the motors varies approximately as the impressed voltage, so it will be seen that after deducting 15.2 h.p. for the fields, the horse power lost in the motor armature and tool varies approximately as the speed. It will be noted that when all these forty-six tools were running at top speed, no useful work being done, the lost horse power was 105 lbs. The full losses given are never incurred, as the tools are never all running at one time and never all on the top motor speed; in fact, the average or even the maximum power consumption on any working day when all the tools are working is less than the maximum for lost power alone. The part of the curve at the right hand in the cut is the total power consumption for all the tools included above and a few constant speed motors besides. These readings were taken every two hours during the six working days succeeding the Sunday on which the readings for power losses were taken.

The record is not quite complete, as it does not give the gear reductions in use; some of the machines were using high speed, some low-speed gears. If all the machines had been run on the highest speed gear the loss in friction in the machines would probably have been doubled.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be restricted to, the grade of material, whether cuts, if heavy, will be of short duration, etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions —assume a cutting speed of 50 to 70 ft. a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than 30 minutes, transfer this into pounds of metal removed per minute, and multiply by 2.7 (this figure is 50 per cent. above the constant 1.8 used previously in this paper, the increase being for safety for bad conditions), then select a motor which will develop this power throughout the range of speed desired.

WESTINGHOUSE TYPE "K" TRIPLE VALVE.

This valve, which was first publicly introduced at the West Seneca tests on the Lake Shore & Michigan Southern Railway last October, is new more in designation than in detail, since it consists of an ordinary Westinghouse quick-action freight triple valve with a small addition and slight modifications in the ports of the valve body and slide valve, designed to meet those conditions existing in the long-train service of the present day, which are not met with entire satisfaction by any present standard triple valve. Any Westinghouse freight triple valve can be made over into the "K" type with very little expense and during the usual time required for general repairs. The principal advantages gained by such modifications are:

1. Quick action in service applications.—This is obtained by venting a certain amount of brake-pipe air to the brake cylinder at each triple valve during the service applications in a way similar to the emergency applications of the old triple valves, with less danger of undesired emergency applications and with a greater degree of sensitiveness of graduation than can be obtained in the present standard valves.

2. Retarded release of brakes on the forward part of the train.—This extremely desirable result is accomplished through an arrangement of ports in connection with a spring affecting the movement of the piston and slide valve in the release position in such a way that either a full or restricted exhaust port can be obtained, as the position of the car in the train requires.

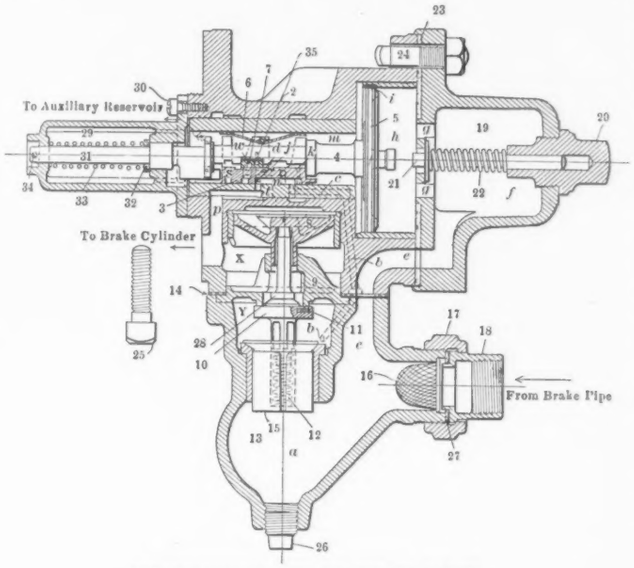
3. Even recharge of auxiliary reservoirs throughout the train.—The "feed port" is so changed in relation to the triple-valve piston that its opening is reduced on such triple valves as are in the "restricted-exhaust" position, while those having the full exhaust opening also have the full recharging opening. This provides that all the brakes in the train may be recharged in about the same length of time.

These very desirable results have long been sought after but never before obtained in a practicable shape. The quick-service feature insures a much more rapid response to service applications of the brakes on all lengths of trains. With the old triple valve on a fifty-car freight train, it is necessary, in order to be sure that all brakes will apply, to make not less than a 7-lb. brake-pipe reduction. With the "K" triple valves under such conditions, a 5-lb. reduction will readily apply all brakes, thus materially reducing the loss of air from the brake pipe during an application. More than that, a reduction of pressure such as will insure the application of all the brakes

on a fifty-car train with the old style of triple valve develops only a small cylinder pressure on the rear cars of the train, while the new valve causes a pressure which is approximately equal on all the cars.

On a 100-car freight train it is impossible, with any present make of triple valve, to apply all the brakes with any service application. This applies even where the triple valves are all in first-class condition. With the "K" triple valve, however, no trouble is experienced in applying all of the brakes on this or even a greater length of train. With the ordinary triple valve on such a train, a 15-lb. brake-pipe reduction applied from 76 to 81 brakes with Westinghouse triple valves used with 8x12-in. brake cylinders. With the 10x12-in. brake-cylinder equipment, the number of brakes that will apply under similar conditions is considerably less than with the 8-in. With the "K" triple valve and its quick-service feature, however, a means of applying all the brakes is afforded with lighter brake-pipe reductions than are required with the old triple valve giving the unsatisfactory results above mentioned.

This retarded-release feature provides a means by which



WESTINGHOUSE TYPE K TRIPLE VALVE.

the brakes can be released at slow speed without any danger of train partings. With the present equipment it is often necessary to bring freight trains to a standstill before releasing the brakes if the speed has been reduced to ten miles an hour or less, and under certain conditions this speed limit is even greater. In many cases, where spring draft gear is used, it is not practicable to release at slow speeds even when the engine is equipped with the independent straight-air brake, the latter being used to control the slack of the train. By proper manipulation of the brake-valve handle, this retarded-release feature puts into the hands of the engineer a means of (1) releasing the brakes at the rear end of the train first; (2) releasing those at the head end first; or (3) releasing the brakes throughout the train all at the same time.

The restricted recharging of the brakes on the forward cars causes the air pressure to rise more rapidly throughout the entire brake pipe and makes more air available in a shorter time for releasing and recharging the rear brakes. This effectually obviates the tendency of the rear brakes to stick, because this tendency is due to the auxiliary reservoirs on the forward end absorbing so much of the air while recharging that the rear cars do not get the presssure required to promptly release their brakes. It also prevents reapplication on the head end after release, due to the brake-pipe pressure there being lowered through the rear brakes still recharging after the forward ones are fully charged.

This feature also permits of the brake-valve handle being allowed to remain in the release position longer without overcharging the head of the train, thus more quickly building up the brake-pipe pressure, and, consequently, recharging the auxiliary reservoirs. Since those brakes at the rear of the train are charged up in about the same time as those at the head end, a more evenly distributed braking power is obtained, causing each brake to do its share of the work and avoiding the overheating of certain wheels.

A fifty-car freight train equipped with the new valve and running at a speed of 20 miles per hour, will be brought to a standstill by a 5-lb. brake-pipe reduction in about 400 ft. shorter distance than with the old type, due to the more prompt application, higher average cylinder pressure and more positive action of the brakes. It requires a 20-lb. reduction with the old triple valves to stop in the same distance as the 5-lb. reduction just mentioned. More than this, the amount of free air saved on a fifty-car train with 10-in. brake equipment, due to the lighter brake-pipe reductions and quick-service feature, is about 25 cu. ft. for every full application. And a full application with the new valve stops the train in 35 per cent. less distance than required with the standard valve.

The present standard Westinghouse freight triple valve may be transformed into the improved type by a simple change, preserving all the old parts except the body, slide valve, slide-valve bush and graduating valve. This can be done when these valves are sent to the brake works for heavy repairs. Thus the cost of re-standardizing is reduced to a minimum, the time required will not exceed that allowed for ordinary repair work, and the railroads will get the advantage of using the parts of their own triple valves.

The accompanying illustration is a central vertical section through the "K" triple valve, from which the changes required to convert the old standard valve into this type will be readily understood. These changes are: a new body, *2;* a new slide valve, *3;* a new graduating valve, 7, of the slide valve type; the necessary modifications in the piston stem, *4*, required by the new type of graduating valve; the new slide-valve bush with proper re-arrangement of ports to suit the new slide valve, and the addition of the retarded-release feature, *29*, which, in the ordinary freight equipment, protrudes into the auxiliary reservoir volume. Besides this, the port *b* is drilled through the body and check-valve case in such a manner as to connect the chamber *Y* above the check valve to a port in the slide-valve seat. In the release position of the valve when used with the 10-in. brake equipment, this port *b* communicates through a port in the slide valve with the slide-valve chamber, and thus with the auxiliary reservoir, permitting air from the brake pipe to raise the check valve *15* and pass through port *b* to the auxiliary reservoir. This in addition to the supply that passes through the ordinary feed groove *i* around the piston, so that in full release position the auxiliary reservoir will charge very rapidly. But if the valve is in the retarded-release position, port *b* connects with a much smaller port through the slide valve, while the piston fits closely against the ends of the slide-valve bush, cutting off any supply through feed groove *i*, thus greatly reducing the rate of recharge. This also applies to the valve when arranged for an 8-in. equipment, except that communication between port *b* and the slide-valve chamber is broken during the full release, all the air for recharging then coming through the feed groove, while during the retarded release the port in the slide valve which opens *b* to the slide-valve chamber is about half the area of the feed groove. This difference exists because of the different volumes of air that have to be handled, while the feed grooves in both valves are the same size.

The retarded-release feature is made possible through the supplementary portion, *29*, which consists of a brass frame casting open on both sides and attached to the triple-valve body by means of three screws, *30;* the stem, *31*, acts as a stop for the triple-valve piston when moving to the release position. Since it is held to its position by the spring, *33*, and collar, *32*, it will readily be seen that by properly proportioning this spring, the stem, *31*, can be made to compress the spring or not, depending on the rate of increase of the brake-pipe pressure in chamber *h*. If the triple valve is on the head

end of the train, where the brake-pipe pressure builds up rapidly, spring, *33*, will be somewhat compressed by the piston when going to the release position, thus allowing the slide valve, *3*, to pass beyond full release position and partly close the exhaust port. As the brake-pipe pressure equalizes throughout the train, and feeds through into the auxiliary reservoirs, the difference of pressures on the two sides of the piston becomes less, and the slide valve is gradually forced back to the full exhaust opening.

The quick-service feature is gotten through port *b*. When the slide valve goes to the service-application position, its arrangement of ports is such that the chamber, *Y*, is connected through port *b* to the brake cylinders. These ports are so restricted that the resulting flow of air from the brake pipe to the brake cylinder through port *b* is not sufficient to cause an emergency application, but will materially hasten the brake-pipe reduction throughout the train. It is for this reason that a much smaller reduction is required at the brake valve to obtain a given brake-cylinder pressure than would be the case with the old type of triple valve. This is true not only because of less air exhausted to the atmosphere at the brake valve, but also because of the additional pressure derived from the air entering the brake cylinders from the brake pipe and thereby causing a higher brake-cylinder pressure.

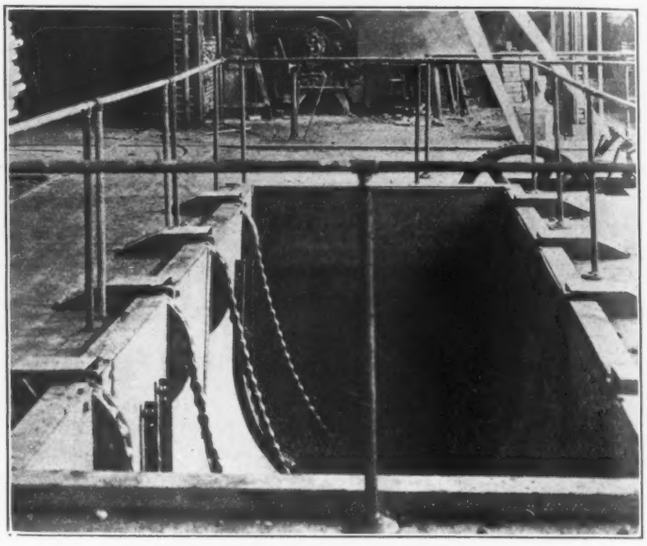
In all other respects the operation of this valve is practically that of the present F 36 or H 49 triple valves. Its outward appearance, when attached to the auxiliary reservoir, is so much like these valves that, to distinguish it, a thin lug is cast on the top of the body in a position easily seen from the side of the valve; and its designation "K-1" or "K-2" is also cast on the side of the body, the former replacing the F 36 and the latter the H 49 standard valves.

A large number of these valves are already in service, giving results that are in every way satisfactory. The serious problems brought forward by the rapidly changing conditions of freight service have made it absolutely necessary to increase the power and flexibility of the air brake. Yet the adoption of any new device would entail such an immense amount of expense and inconvenience, that the arrangement above outlined whereby the valves now in service can be utilized and transformed to give the required results with only a slight addition to the number of parts and with little expense, will prove to be one of the most important improvements yet brought out in connection with air-brake equipments.

COMPARATIVE SAFETY OF TRAVEL IN UNITED STATES AND ABROAD.—I have collected some data from other sources, and have, as far as possible, verified it. During the year ending June 30th, 1903, the total number of passengers killed on railroads operating in European countries was 536; in the United States these figures aggregated 321. The mileage of the European roads was 177,363, and in the United States 207,977 miles, so that for every 331 miles of road in Europe during this period you will note one passenger was killed, as against one passenger to each 648 miles in the United States, which suggests the conclusion that fatalities to passengers are not greater on American than on foreign railways. In point of fact, during the period mentioned, such fatalities seem to be at the ratio of 2 to 1 in favor of United States railways.—*Mr. W. G. Besler, New York Railroad Club.*

NEW MACHINE FOR CLEANING FLUES.

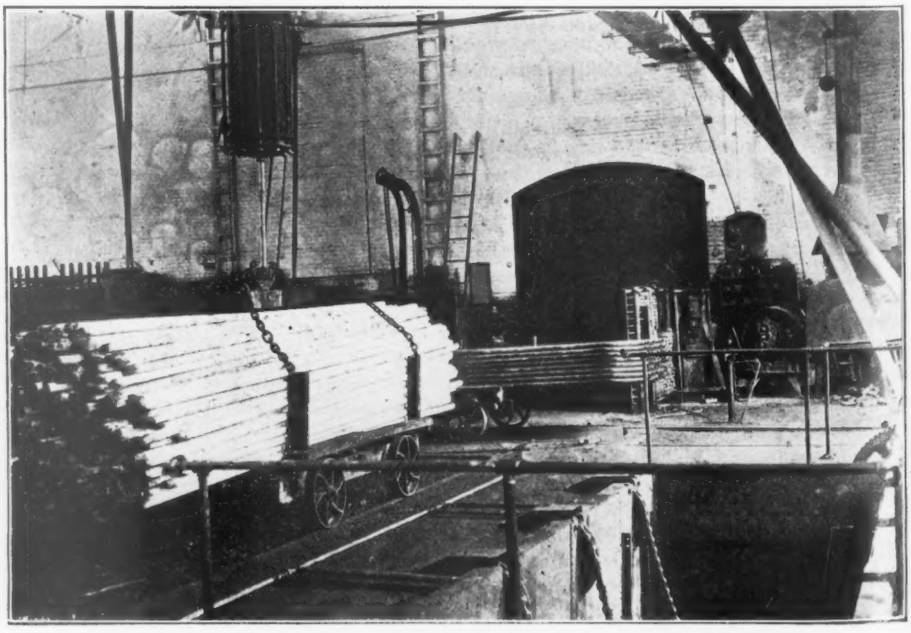
A new machine for cleaning flues has recently been installed at the South Tacoma shops of the Northern Pacific Railway, which is similar in principle to those in use at the Topeka shops of the Atchison, Topeka & Santa Fe Railway and the Angus shops of the Canadian Pacific Railway, the construction and operation of which were fully described and illustrated on page 221 of the AMERICAN ENGINEER AND RAILROAD JOURNAL, June, 1904. The advantages of these machines are that they will clean a larger number of flues at one time and clean them quicker than by other methods. As the flues



NEW MACHINE FOR CLEANING FLUES.

are rolled under water the noise is greatly reduced. The cost of handling the flues in and out of the machine is reduced to a minimum.

The overhead works have been done away with on the machine at South Tacoma, making it more compact and convenient. Instead of having only two sprocket chains, one of which is adjustable to suit the length of the flues, there are four sprocket wheels mounted on a shaft on each side of the tub, or tank, as shown in the illustration. These sprocket wheels are so placed that the chains will clear the sides and



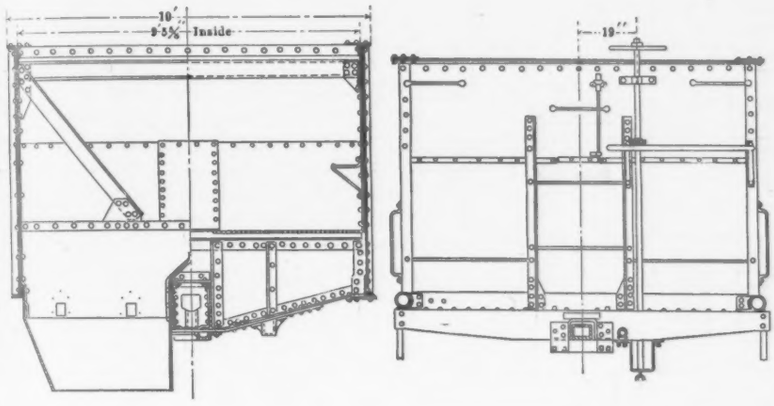
AIR HOIST ABOUT TO REMOVE FLUES FROM TRUCK TO MACHINE.

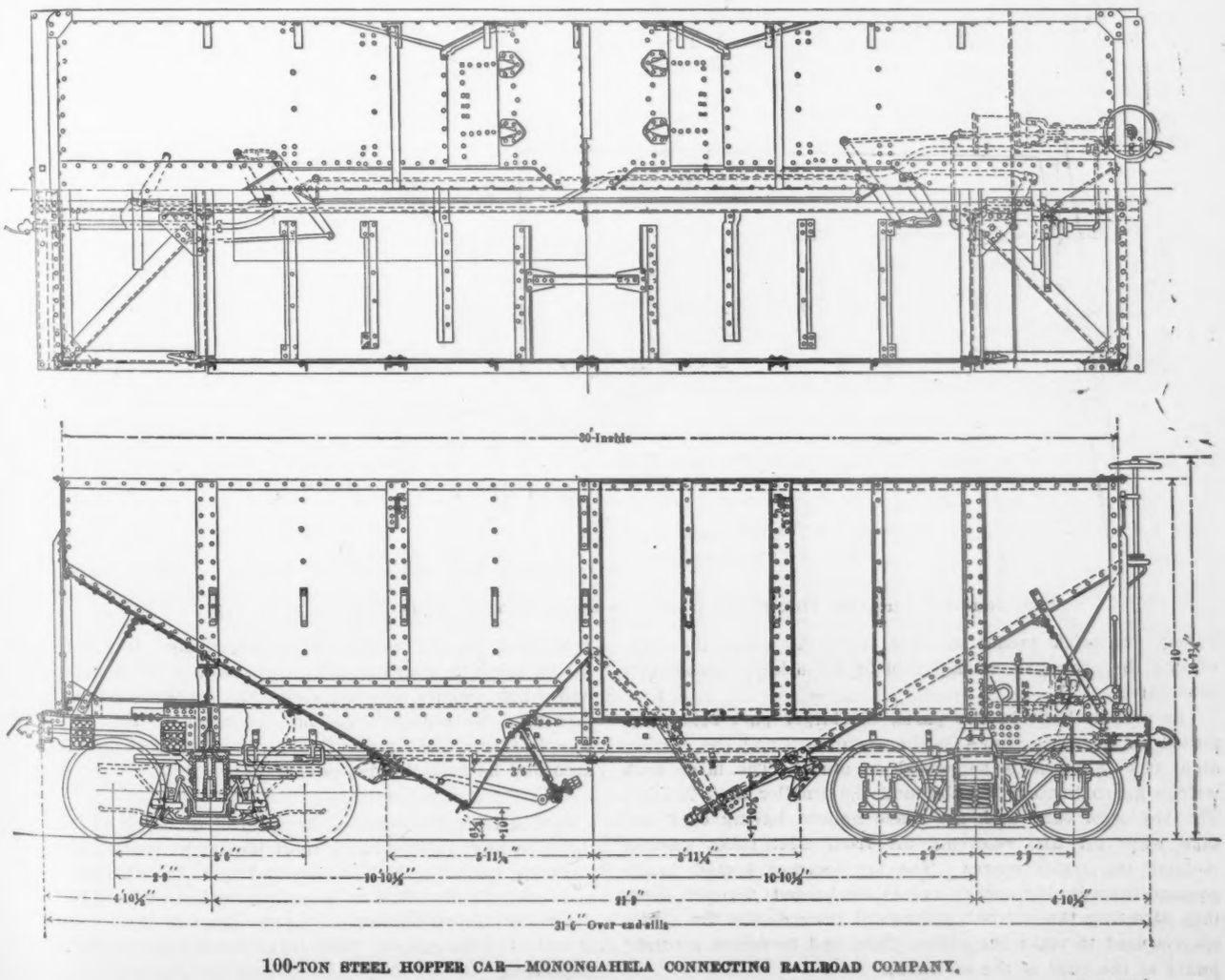
bottom of the tank by about 6 ins. The tops of the sprocket wheels are about level with the floor line. There are a number of idlers at the bottom of the tank, so situated that the brackets upon which they are mounted answer for the legs of the tank and allow about 1 in. clearance for the chain to pass under the bottom of the tank.

The flues are raised and lowered into the tank by means of an overhead trolley air hoist. The chains which handle the flues are allowed to remain in the tank during the process of cleaning, so that it is only necessary to attach the hoist to the chains when they are ready to be removed. One of the illustrations shows a truck load of 378 2-in. flues, weighing about eight tons, which are just about to be hoisted from the truck and lowered into the pit. Larger sets of flues are handled easily. It requires from 2½ to 3 hours to clean them, unless they are very bad. The tank is 6 ft. 6 ins. deep and 20 ft. 6 ins. long. To keep the flues in position, shields or fenders are provided in the tank, which are adjustable for different lengths of flues. We are indebted to Mr. R. M. Crosby for the information and photographs. These machines are made by Joseph T. Ryerson & Son, Chicago.

100-TON STEEL HOPPER CAR

The Monongahela Connecting Railroad Company at Pittsburg has in service a number of cars which were built to carry 100 tons of ore at slow speeds. The bodies of these cars, when they were furnished, were quite similar to the body of a 100,000-lb. capacity car as ordinarily furnished by the car builders. They were designed to carry the lading evenly distributed and were intended to carry ore from the stock yards to the furnaces, about three-quarters of a mile. The cars gave very good service until it was decided, in order to facilitate the unloading, that the load should be concentrated over the hopper doors. Under these conditions there was found to be some deflection in the sides at the bottom edge and the top of the sides buckled, taking the form of a reverse curve. The angle at the top of the sides was 3½x3½x5/16 ins., and in order to strengthen the car a 5x5x½ in. angle was added. The first car to be strengthened in this manner was tested with increasing loads up to 272,500 lbs. of ore, which was carried from the stock yards to the furnaces, the car not showing any sign of weakness. Since that time all the other cars have been strengthened in this manner.





100-TON STEEL HOPPER CAR—MONONGAHELA CONNECTING RAILROAD COMPANY.

The sides of the car are ¼ in. thick and the centre sills are 15-in. channels. The cars are equipped with Westinghouse friction draft gear. The axles have 5¾x10-in. journals. The body of the axle is of uniform diameter instead of being tapered in the middle, as is the usual custom. Although there have been several derailments of these cars, there has never been any failure on the part of the journals or axles. Cast-steel truck bolsters furnished by the American Steel Foundries are used. The cars were built by the Standard Steel Car Company. We are indebted to Mr. H. W. Watts, master car builder, for drawings and information.

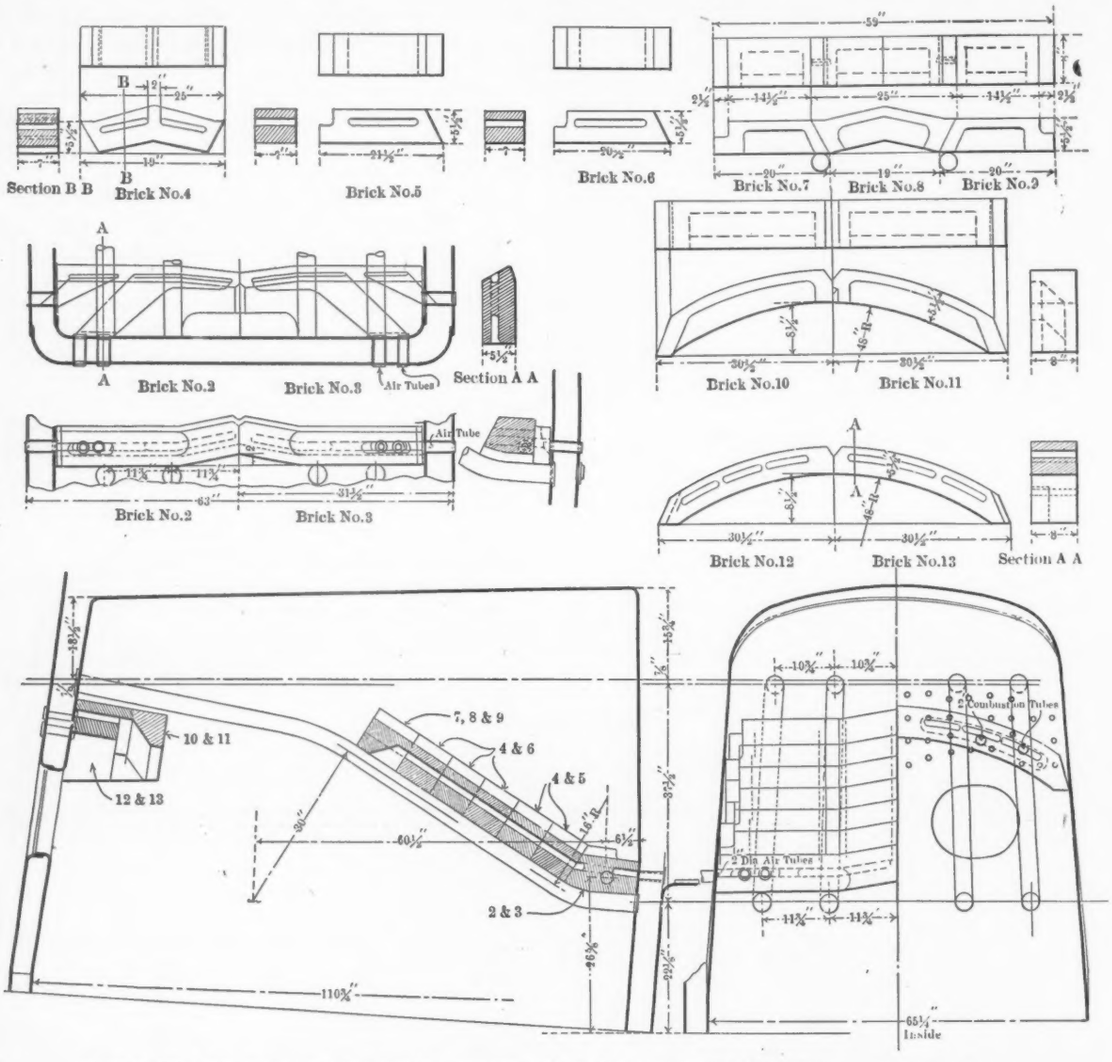
WADE-NICHOLSON HOLLOW BRICK ARCH.

Through the courtesy of Mr. Robert Quayle, superintendent of motive power of the Chicago and Northwestern Railway, drawings have been received illustrating the application of hollow fire brick arches on that road, the engravings presenting the arrangement employed in Atlantic type passenger locomotives.

The arch is built in two parts, the larger part being supported on the water tubes in the usual way and the smaller arch over the door is supported on studs. The large arch weighs approximately 929 lbs. and the smaller arch 310 lbs. The blocks of each arch are made hollow, having oval passage ways for air, receiving air from 2-in. tubes passing through the water spaces. The air becomes heated in its passage through the arches and is discharged, through openings directing the current, downward towards the fire. Fire clay is used to make the arches tight and to secure air-tight joints at the ends of the air tubes.

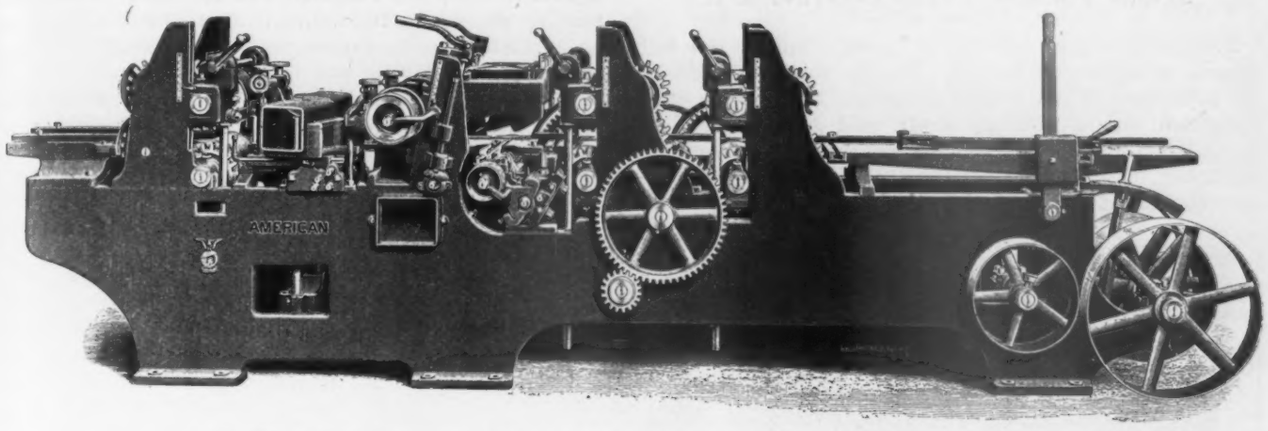
Mr. Quayle states that he has used about 200 of these arches, covering a period of eight months, and that he finds their life to be about three times that of the ordinary arch. He also states that it produces a practically smokeless condition while the locomotive is working, which means that proper combustion is taking place in the firebox and that unconsumed carbon does not pass out of the stack in the form of smoke. The result in economy has not yet been determined by tests, but on the Wisconsin division where the most thorough trials have been made the master mechanic reports considerable saving in fuel.

In order to get the best work out of the locomotive the firemen are obliged to fire lighter than they would without this arch, which constitutes a strong feature of this device, because heavy firing is not only the cause of black smoke but also produces dirty fires, clinkered grates and a consumption of more coal than is required with light firing. In order to get at the tubes the central portion of the large arch is removed, and when repairs are completed the central portion of the arch may be replaced without detriment to the arch. Mr. Quayle states that this arch does not cost more than the old arch and he finds decided advantages in it.



WADE-NICHOLSON HOLLOW FIRE BRICK APPLIED TO ATLANTIC TYPE LOCOMOTIVE—C. & N. W. RY.

BOILER TUBE DIAMETER.—The ratio of diameter to length of the tube undoubtedly has a most important bearing upon the steaming qualities of the boiler and upon the efficiency of the heat absorption. This is more particularly noticeable when the boilers are being worked to the limit of their capacity.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*



NO. 131 AMERICAN SERIES PLANER AND MATCHER, WITH LOWER CYLINDER CUTTING FIRST.

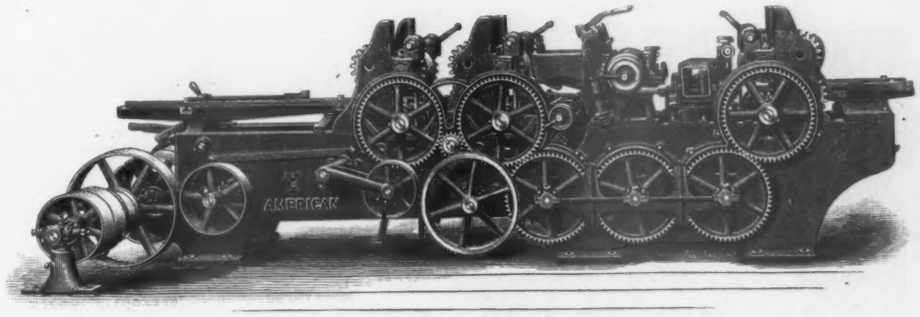
AMERICAN PLANER AND MATCHER.

The American planer and matcher, illustrated herewith, is a medium weight machine, with all of the essential features and adjustments that have proved of value in up-to-date planing mill practice. Special attention has been paid to make all parts easy of access, either for adjustment or repair, and the sides are so designed that it is convenient to get under the machine from either side. Special bolts, with only two sizes of heads, are used in all the working parts, so that it is possible to set up the machine and make all necessary adjustments with one wrench. These machines are built in two sizes, 9 and 15 ins. wide; they will surface from ⅜ in. to 6 ins. thick, and joint and match from 2 ins. to the full width of the machine.

The feed consists of six 9½-in. rolls, geared at both ends, fitted with a parallel lift, and having adjustable spring pressure, which gives a feed at any rate between 40 and 120 ft. per minute. The upper and lower heads are of hammered crucible steel and are interchangeable. They are slotted on all sides, have projecting chip breaking lips, and carry 4-in. knives with a cutting circle of 7½ ins. The journals, 2¼ ins. in diameter, running in self-oiling boxes that are yoked together both before and behind the cut, in connection with pneumatic pulleys with ample belt surface, effectually prevent undue friction and loss of power. Both the upper and lower heads have leveling devices for lining up with the bed of the machine. The upper head chip breaker and the upper and lower head pressure bars have a lateral adjustment, that permits the use of a knife that projects 1 in. beyond the lip of the head. Tool steel points that are easily adjusted or replaced in case of need are fitted in the upper chip breaker. The pressure bar at the rear of the upper head is rigid, but has a vertical adjustment while the machine is running.

The lower head is placed just in front of the upper head, giving a smooth surface on the under side of the stock to rest on the bed while the upper or finishing cut is taken. It pulls out by means of an accurately cut screw of coarse pitch for setting or sharpening of knives, and when replaced is securely locked in position by a hand lever. It may be adjusted vertically while the machine is running to bring the top of the cutting circle in exact line with the rear pressure bar. Two pressure shoes, with adjustable spring pressure, hold the stock while passing over the lower head, and are carried by the upper head yoke. The bar in front of the lower head and the two lower in-feeding rolls are so arranged that, by moving a lever at the front end of the machine, the cut of the lower head may be changed as desired while the machine is running, without altering the finished thickness of the stock or disturbing the cutter head, and any desired amount of stock may be removed up to ¼ in. If desired, the machine can be instantly adjusted for single surfacing without removing any of the belts.

The side head spindles are of crucible steel, 2 ins. in the bearings and 1 13/16 ins. where heads go on, ground true and run in self-oiling boxes; pneumatic pulleys effectually prevent slipping of belts. The lower end of the spindle rests on an adjustable bronze step immersed in oil. The side-head yokes are made in two parts; by loosening four bolts the part that holds the spindle may be taken out for rebabbitting without removing the screws, lock shafts or the part of the yoke that rests on the way. The side-head pressure feet are readily adjusted and locked while running. Both heads are quickly adjusted from the side of the machine by screws and are fitted with a device for taking up lost motion. Each head has an independent clamping device. The chip breakers for the side heads have tool-steel points that are easily replaced in case of wear. These machines, made by the American Woodworking Machinery Company, require from 10 to 15 h.p. for driving and weigh about 11,000 lbs.

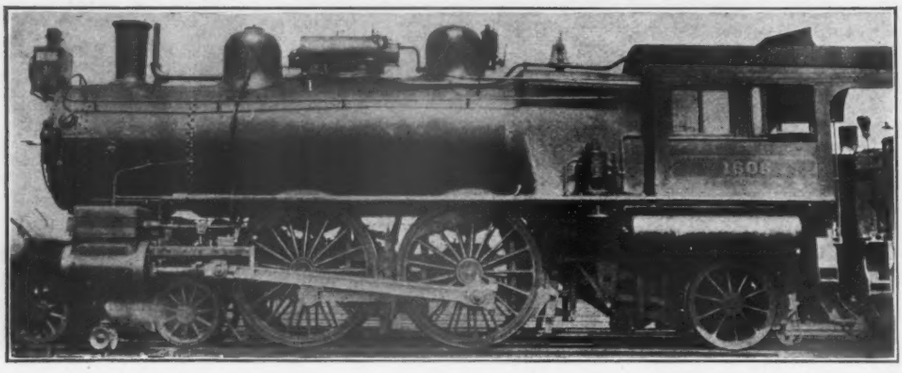


VIEW SHOWING GEARED SIDE OF PLANER AND MATCHER.

ELECTRIC DRIVING OF MACHINE TOOLS.—While the losses of power in transmission by shafting and belting are very generally represented by 50 per cent. of the output at the engine, the corresponding losses in the case of electric transmission from engine to tool are rarely more than 25 per cent. But it must be borne in mind that losses for mechanical transmission are constant and that those for electric transmission vary with the energy consumed. Hence the power required for electrically driven tools is usually much less than half that necessary for belt-driven tools. In addition to the saving of power, electric driving possesses the further advantage, that a greater output per machine is obtainable, owing to the flexibility of the method, and, further, its cleanliness and the non-obstructiveness to overhead cranes are features of much importance in many engineering workshops.—*Engineering Review.*

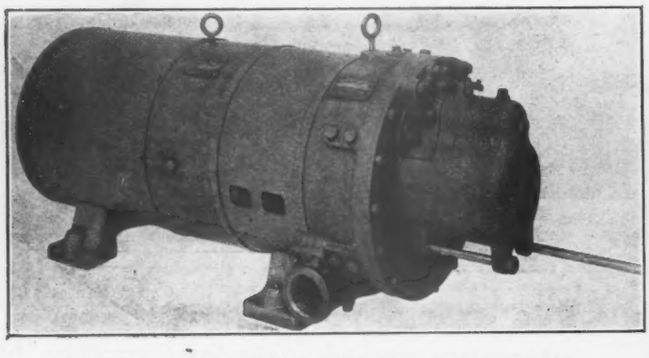
STEAM TURBINE TRAIN LIGHTING SET.

Electric lighting for the cars on through trains is now very general throughout the country. It is not necessary to discuss the advantages of this method of lighting, for they are easily recognized, but as with any newly tried devices there have been disadvantages of more or less serious a nature from the beginning, these usually, however, being concerned with the source of current.



TURBINE TRAIN LIGHTING SET MOUNTED ON LOCOMOTIVE.

The usual methods of generating electricity for train lighting can be divided into three general classes: first the direct storage battery, which is fully charged before the car or train leaves the yards, is of sufficient capacity to furnish the lights in that one car or train for its whole run; second, generators installed on the truck and driven from the axle, which are supplemented by a storage battery for use when the car is not in motion, and third, the steam-driven generator located usually at the head end of the forward baggage car, steam being obtained from the locomotive through flexible connections. This system does not usually include a storage battery auxiliary, although such can be used if desired. Each of these systems have been developed, and it is possible to obtain efficient and satisfactory lighting by either of them,



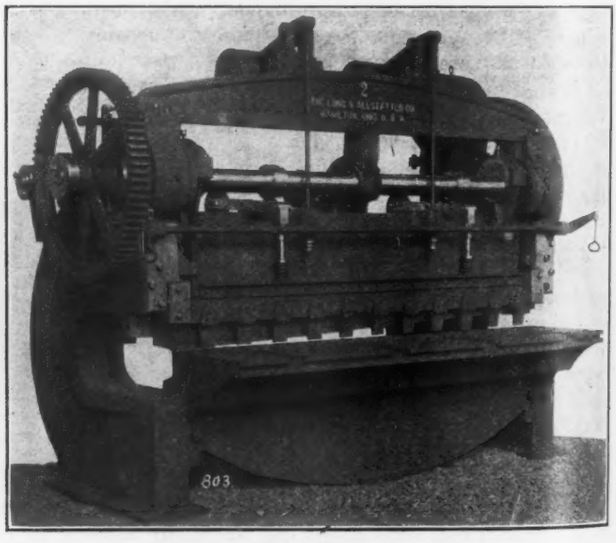
TURBINE TRAIN LIGHTING SET—GENERAL ELECTRIC CO.

the choice being determined by the cost of installing and operating and the difficulty of operation and maintenance.

There has recently been developed by the General Electric Company a new train lighting set, which consists of a generator directly coupled to a Curtis steam turbine, the two mounted on one base, and forming a very compact generating set. This set, which is illustrated herewith, is adapted for installation either in a baggage car, where it occupies a minimum amount of room and eliminates the vibration usual with the reciprocating engine set, or can be mounted directly upon the locomotive itself. The latter scheme has the advantage of doing away with any flexible steam connections, and permits the engineer to control the apparatus. One of the views herewith shown illustrates how this set appears mounted upon the locomotive boiler.

An apparatus of this nature is not unfamiliar to railroad men, as a similar generating set for electric head and cab lighting has been in quite general use. In this case a similar apparatus, but of size sufficient to furnish lights for the whole train as well as the locomotive is used. These sets are now to be obtained in three sizes, with generators of 15 k.w., 80 volts, 20 k.w., 125 volts, and 25 k.w., 125 volts. In each case the set consists of a suitable size single stage Curtis steam turbine direct connected to a two pole direct current generator. These generators, because of their high speed, the largest one running at 3,600 r.p.m. and the medium size at 4,500, are very small and compact for their capacity. The complete set for the smallest size weighs but 1,850 lbs.

The turbine is constructed to operate at steam pressures of from 80 to 200 lbs., and exhaust directly into the atmosphere. The speed is controlled by a centrifugal tension spring governor operating a balance poppet valve, and will carry its full rated load until the steam pressure drops below 75 per cent. of the normal pressure. Liberal bearing surface is provided, the journals between the generating and turbines on the 25-k.w. set being 3 by 13 ins. and the end journals being 1½ by 6 ins. The bearings are lubricated by pressure oil, there being a pump geared to the generator end of the shaft and giving about 5 lbs. of oil pressure. Oil rings are also provided. On the two smaller size sets lubrication is obtained from oil rings alone. The voltage of the generator is regulated by a field rheostat, the electrical instruments being placed in the cab when the set is mounted on the locomotive. The 25-k.w. set will supply about 430 sixteen-candle power lights, including the locomotive headlight. The machine can be run with the headlight alone when the engine is disconnected, in which case the car lights are usually supplied by a small storage battery.



MOTOR DRIVER GATE SHEAR.

These generating sets are now in operation on several of the principal railroads in the country, and are reported to be operating satisfactorily.

HEAVY MOTOR-DRIVEN GATE SHEAR

The accompanying illustration shows a new motor-driven gate shear with a 20-in. throat, made by the Long & Allstatter Company, Hamilton, Ohio, and designed to cut sheets 100 in. long by ⅜ in. thick. It is provided with automatic hold-down clamps which securely hold the sheet while it is being sheared, and with an automatic stop which brings the slide to rest at the completion of each stroke, with the blades open ready for the next cut. The motor is mounted on a bracket on the rear

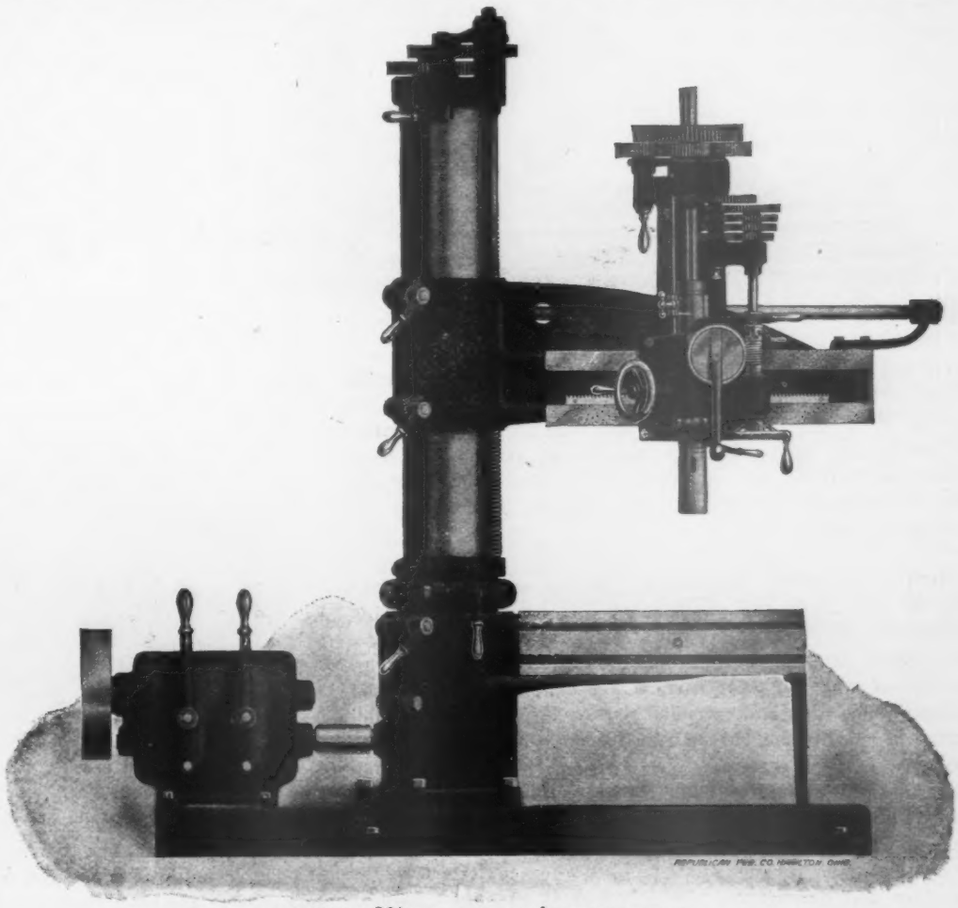
of one of the housings. The cam shaft is of forged steel and has a centre bearing, as shown. The table, to which the lower blade is attached, is adjustable.

3½ FOOT RADIAL DRILL.

The American 3½-ft. plain radial drill, illustrated herewith, has been specially designed to meet the heavy duty imposed by the use of high-speed twist drills. The speed box, which provides four changes of speed, each being instantly available by the use of the two levers shown, is of the geared friction type. The frictions are of very simple and strong design and very powerful. The speed box can readily be removed and replaced by a cone, if so desired. Where a motor drive is used, the builders recommend that it be connected to the speed box through gearing.

The column is of the double tubular type. A sleeve or outer column revolves about an inner column which extends nearly to the top of the outer column, thus making a very rigid construction. The arm is of a parabolic beam and tube section, making it very effective for resisting both bending and torsional strains. The lower line of the arm is parallel with the base of the machine, thus permitting work to be operated upon close to the column. The arm is raised and lowered rapidly by a double-thread coarse pitch screw which is controlled by a lever conveniently placed. The head is moved along the arm by a hand wheel through an angular rack and spiral rack pinion. It can quickly be locked into position by a conveniently placed clamping lever. Back gears are located on the head. The spindle has eight changes of speed ranging from 37 to 295 revolutions per minute, all available without stopping the machine.

The feed mechanism provides four changes, ranging from .0069 to .0203 in. per revolution. The feeds can be automatically tripped at any position of the spindle by an adjustable trip dog and pointer acting on the worm clutch. This trip acts automatically at the full depth of the spindle, thus preventing breakage of the feed mechanism. The tapping mechanism is carried on the head between the back gears and the speed box, thus giving to the frictions the benefit of the back gear ratio, making unusually heavy tapping operations possible and also permitting the taps to be backed out at high speed. The box table has a top surface of 16 by 32 ins. and a side surface 6 by 32 ins. The greatest distance from the spindle to the base is 4 ft. 3 ins.; the spindle traverses 10 ins. and the head traverses 2 ft. 10¾ ins. on the arm. No wrenches are required with this tool. It is made in three sizes, with 2½, 3 and 3½ ft. arms, by the American Tool Works Company, Cincinnati, Ohio.



AMERICAN 3½-FT. ARM PLAIN RADIAL DRILL.

Railroad Y. M. C. A.—Ten years ago the railroad companies paid 60 per cent. of the cost of the R. R. Y. M. C. A. while the men paid 40 per cent; this last year the companies paid 40 per cent. and the men 60.—*Central Railway Club.*

Tide Computing Machine.—The Coast Survey at Washington, D. C., has an intricate machine, invented by Prof. William Ferrel, which cost about $3,500, and accurately predicts the time of high or low tide for a given locality. The machine takes into account 19 different elements which affect the tide and does the work of 40 expert computers. A new machine is now being built, which will take into account 39 elements which affect the tide, and will operate automatically, making predictions for as long a time as desired.

Forging and Machining Locomotive Frames.—Hammered or forged iron may cost 3c. per lb., while the scrap turnings or borings will not net over ½c. per lb. If the frame forge men will work carefully and keep the stock on a main frame within ¼ in. all over, they will do their work as well as could be expected; but for every additional 1-16 in. there will be a dead loss of $3 to $4. Thus it is not always a question of how cheaply you can plane frames, but how you can best forge them.—*Mr. C. J. Crowley, Western Railway Club.*

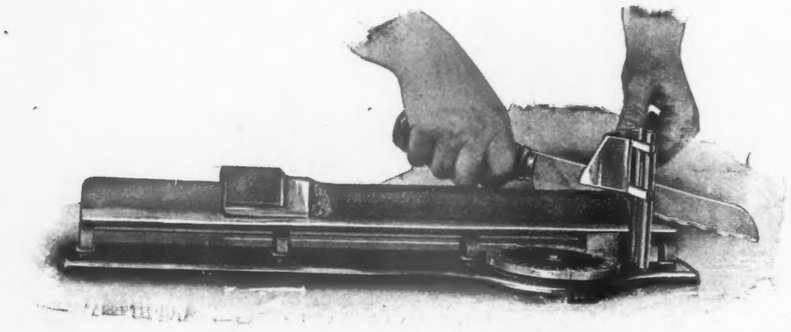
Commercial Engineer.—In a characteristic address at the annual smoker of the Railway Club of Pittsburgh, Mr. Geo. A. Post argued that the man who sells things is entitled to a degree, and suggested that he be called a "commercial engineer." The members of the club were so pleased that they have had an abstract of the address attractively printed on large sheets of paper suitable for framing. If it is in order, we would suggest that some one "start the ball rolling" by conferring a "master's" degree upon Mr. Post. He deserves it.

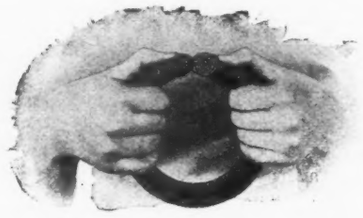
The Mechanical Index.—The Donnell-Colvin Company, 256 Broadway, New York, have purchased *The Mechanical Index* from the publishers of *Machinery*. The "Index" will contain the names of all manufacturers of mechanical tools and appliances. Both of the above gentlemen are specially well fitted for the work, and they promise that the results of their efforts will soon be apparent.

EXACTO PACKING GAUGE AND CUTTER.

The difficulty of cutting continuous length packing so that it will exactly fit the rod or stem to be packed is well understood by those who have to perform this operation. Recognizing this trouble, Greene Tweed & Co., New York, have recently perfected a device which will easily and quickly perform this operation, so that the packing will exactly fit the rod, and that without any waste. The illustrations herewith give a clear idea of the appearance and general operation of this instrument. It will be seen that it consists of a guide for the packing which has an adjustable stop operated by means of a dial. At one end of the guide is a knife guide, which is held in place by a spring, the cutting being done by a serrated edge knife fitting into this guide.

In operating the instrument the dial is set at a figure which represents the diameter of the rod to be packed plus the thickness of the packing to be used. One end of the packing is then cut off at the bevel by the knife and is then pushed



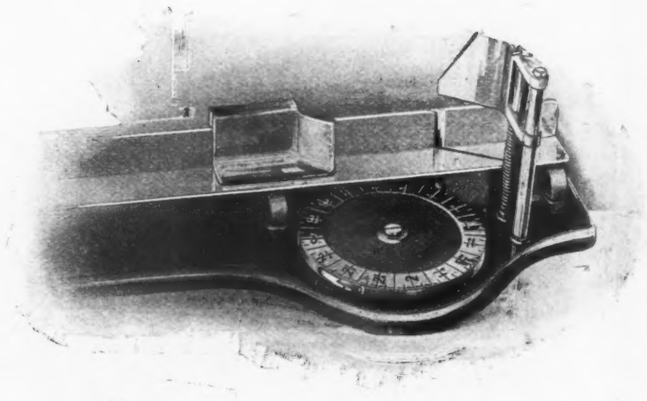


along the guide until it rests against the stop, when the knife guide is pressed down to hold the packing secure and the section is cut off. This can be duplicated for as many rings as are needed, each of which will be of exactly the same length, and will fit the rod exactly if the dial is properly set. The illustrations clearly show the different features of the instrument and method of operation.

Heating One-Story Buildings.—"So far as their construction is concerned, the simplest of all structures requiring ventilation and heating are one-story biuldings, such as mills and shops. But no other form of building has so large an amount of wall and roof surface per cubic foot of enclosed space, or such high and extended rooms; in fact, such a building, as a rule, forms only a single room. As a consequence the most efficient system is necessary; it is not alone sufficient that the apparatus shall be large, to allow for the excessive heat loss from the building, but, above all, the arrangement of the distributing ducts must be such as to most economically utilize the heat supplied; for underheating at the floor and overheating above is one of the most natural consequences of an imperfect system of distribution. Under such circumstances the apparatus itself is frequently condemned as having insufficient capacity, when the trouble lies entirely in the manner in which the heated air is delivered to the building.

"In buildings of this type the principal provision is to be made for the heating, for the occupants are generally separated and the air supplied for heating will answer all the requirements of ventilation. But it is, nevertheless, necessary that they should be provided with fresh air in sufficient quantity. One of the inherent virtues of this method of heating is that it ensures such supply. As the air provided is generally in excess of that required for ventilation, increased economy can be secured by using over again a portion of the previously heated air. This may be done by arranging dampers or doors so that part of the air entering the heater is drawn from out of doors and part, or, if desirable, the whole from the room. In fact, in the ordinary manufactory the common practice is to nominally take the entire air supply from within the building. This does not result, as might be supposed, in a total lack of ventilation, for a very considerable amount of outward leakage takes place through the walls and around windows and doors. Sufficient, indeed, to cause a similar inward, but imperceptible, leakage at other points in such quantity as to result in a comparatively frequent change of air within the building.

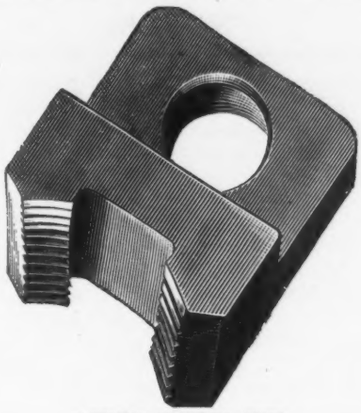
"One of the greatest difficulties in a building of this character is to heat it rapidly in the morning, after it has cooled during the night. No other system can so completely and rapidly meet this requirement as that here presented. When it is desirable, the engine may be run slowly all night, and the building maintained at a moderate temperature. The exhaust from the engine being used in the heater, no expense is entailed for motive power."—*Extract from Treatise on Ventilation and Heating published by B. F. Sturtevant Company.*



Flat and Curved Crown-Sheets.—The gradual extension of the practice of making the top of the firebox and casing flat instead of round is noticeable. On the Great Western Railway less trouble has been experienced with the flat-top firebox than with the round top, although no slingstays of any kind are used. The flat top has the important advantage of increasing the area of the water line at the hottest part of the boiler, and so materially contributes to the reduction of foaming. This, combined with the coned connection to the barrel, has enabled the dome, always a source of weakness, to be entirely dispensed with and drier steam obtained. The author some years ago made an experiment to settle this much-disputed point. Two identical engines and boilers were taken, one boiler having a dome in the usual position on the barrel, the other having no dome, the steam being taken by a pipe from the top of the flat firebox casing. The engine without the dome proved to be decidedly freer from priming than the other. The liberal dimension of 2 ft. between the top of the firebox and the inside of the casing no doubt contributed to this satisfactory result.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*

DOUBLE TAPERED DIES.

The illustration shows the double taper used in all Armstrong dies. As will be seen, the threads at the entrance of the die are given a greater taper than the standard. This forms a natural and easy lead for the dies, allowing them to start on the pipe with the least possible pressure and without the use of the lead-screw. By reason of this double taper it



DOUBLE TAPERED DIES.

is not necessary to file off the swelling or burr often formed by the cutting tool on the end of a piece of pipe. The advantages of the double taper may be illustrated by the fact that it is an easy matter for one man alone to start the thread on a 2-in. or even larger pipe without resorting to the lead-screw. These dies are made by The Armstrong Manufacturing Company, Bridgeport, Conn.

IMPROVED PASSENGER TRAFFIC CONDITIONS.—The following figures, with reference to railways in the United States, should prove interesting, in comparison with conditions ten years ago, namely, 1894: Railroad mileage in 1903 increased 16 4/10% over 1894; passengers carried in 1903 increased 28½% over 1894; passengers carried one mile in 1903 increased 46 3/10% over 1894; passengers killed in 1903 increased 9½% over 1894. From the above it will be noted that while the number of passengers carried increased during the past ten years 28½%, the number of fatalities to passengers increased but 9½%.—*Mr. W. G. Besler, New York Railroad Club.*

PERSONALS.

Mr. W. McAllister, master mechanic of the Pennsylvania Railroad at Camden, N. J., has been retired under the pension rules of the company.

Mr. J. J. Cavanaugh has been appointed master mechanic of the San Luis Division of the Mexican Central Railway, vice Mr. Thos. Smith, resigned.

Mr. H. W. Johnson has been appointed master mechanic of the Brookfield Division of the Chicago, Burlington & Quincy Railway, succceeeding Mr. A. N. Willsie.

Mr. H. G. Huber has been appointed assistant master mechanic of the Pennsylvania Railroad at Verona, Pa., to succeed Mr. Taber Hamilton, transferred.

Mr. B. E. McNierney has been appointed master mechanic of the Tacoma Eastern R. R. with offices at Bismarck, Wash., to succeed Mr. H. F. Weatherby, resigned.

Mr. D. A. Ross has been appointed road foreman of engines for the Beaumont Division of the Gulf, Colorado & Santa Fe Railway, vice J. J. Wagner, resigned.

Mr. A. S. Williamson has been appointed mechanical inspector of the Mexican Central Railway, with office at Aguascalientes, Mexico.

Mr. M. E. Wells, who was recently appointed traveling master mechanic of the Wheeling & Lake Erie Railroad, has been appointed assistant master mechanic with office at Columbia, Ohio.

Mr. M. J. McCarthy, who was recently appointed master mechanic of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind., will also have jurisdiction over the Indiana, Illinois & Iowa.

Mr. Austin J. Collett has been appointed electrical engineer of the Union Pacific Railroad, under the superintendent of motive power and machinery, with headquarters at Omaha, Nebraska.

Mr. A. C. Hinckley, heretofore master mechanic of the Cincinnati, Hamilton & Dayton Railway, has been appointed superintendent of motive power, including the car department, with headquarters at Lima, Ohio.

Mr. Peter Harvie, superintendent of shops of the Great Northern Railway at Havre, Mont., has been transferred to Everett, Wash., in a similar capacity. He has been succeeded at Havre by Mr. K. A. Froberg.

Mr. C. H. Andrus, heretofore general foreman of the West Philadelphia shops of the Pennsylvania Railroad, has been appointed general locomotive inspector of that company, and will have his headquarters at Altoona, Pa.

Mr. G. W. Seidel has resigned as master mechanic of the Chicago, Rock Island & Pacific Railway, at Horton, Kansas, and has been succeeded by Mr. W. L. Harrison, who has been transferred from Cedar Rapids, Iowa.

Mr. C. H. Burk has been appointed assistant superintendent of machinery of the Mexican Central Railway, with headquarters at Aguascalientes, Mexico. Mr. R. H. Rutherford has been appointed master mechanic, Chihuahua Division, vice Mr. C. H. Burk.

Mr. James Coleman has been appointed master car builder of the Central Vermont Railway, with office at St. Albans, Vt. Mr. A. Buchanan, heretofore superintendent of the motive power and car departments, will hereafter devote his entire time to the motive power department.

Mr. A. W. Wheatley has been appointed assistant superintendent of motive power of the Union Pacific Railroad, with headquarters at Omaha, Neb. Mr. Wheatley recently resigned as superintendent of the East Moline shops of the Chicago, Rock Island & Pacific Railway.

Mr. Edward Eldon, general locomotive inspector of the New York Central & Hudson River, has been appointed master mechanic at East Buffalo, N. Y., to succceed Mr. William Smith, who has been granted an extended leave of absence on account of ill health.

Mr. A. Forsyth, heretofore master mechanic of the Chicago, Burlington & Quincy Ry., at Aurora, has been appointed superintendent of shops at the same point. Mr. A. N. Willsie has been appointed master mechanic of the Aurora Division and Mr. P. J. Murrin, assistant master mechanic of the same division, has been assigned to other duties.

Mr. H. M. Meason, assistant master mechanic Pittsburgh Division, Pennsylvania Railroad, has been appointed general shop foreman on the Philadelphia Division; he is succeeded by Mr. C. J. Halliwell, engine-house foreman at Youngwood, who is in turn succeeded by Mr. J. W. Oschea, engine-house foreman at Conemaugh, Pa.

Mr. J. N. Mowery has been appointed mechanical engineer of the Lehigh Valley Railroad, instead of Mr. J. N. Mallory, as stated in our last issue.

BOOKS.

Link Motions, Valves and Valve Setting. By Fred H. Colvin. 82 pages, 4 by 6. Flexible cover. Published by the Derry-Collard Company, 256 Broadway, New York. Price 50c.

This is a modern treatise on the valve motions of the present day as operating both slide and piston valves. It is thoroughly illustrated and clearly written. It describes the different valve motions as applied to locomotives; carefully explains the proper method of setting and gives comprehensive rules and explanatory notes for setting. The Walschaert and other motions comparatively new to American practice are described.

CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

THE MCEWEN ENGINE.—Bulletin No.17, from the Ridgeway Dynamo & Engine Company, Ridgeway, Pa., presents a detailed illustrated description of the various features of these engines.

POWER PUNCHING AND SHEARING MACHINERY.—A small and well-illustrated pamphlet from the Long & Allstatter Company, Hamilton, Ohio, describes their different lines of punching and shearing machinery.

ROPE DRIVING.—The George V. Cresson Company, Philadelphia, have issued an interesting pamphlet on the subject of rope transmission. Its advantages are considered, the different systems of rope drive are described and several pages of valuable data are presented.

CENTRIFUGAL SPRINKLING CAR.—An attractive pamphlet from the J. G. Brill Company, Philadelphia, Pa., describes their centrifugal sprinkling car, which is adapted for street railroads and is radically different from the ordinary type of sprinkler. It is giving very satisfactory results on several roads on which it is used.

ROTARY CONVERTERS FOR RAILWAY SERVICE.—Bulletin No. 4433, from the General Electric Company, describes the construction of their rotary converters for railway service. This company has built 842 rotary converters for railway work alone, not including those used in lighting plants, the aggregate capacity of which amounts to 384,030 k. w.

REINFORCED CONCRETE.—A 160 page 5 by 8 in. catalog, from the Trussed Concrete Steel Company, Detroit, Mich., is devoted to a description of the Kahn trussed bar, records of several tests of the Kahn system of reinforced concrete and a number of illustrations of its application, notable among which is the roundhouse of the Grand Trunk Railroad at New Toronto, Ontario, Canada.

LINK MOTION.—H. B. Underwood & Company, of Philadelphia, are sending out to the master mechanics and superintendents of motive power of the various railroads copies of the treatise on "Link Motion," by Mr. Fred. H. Colvin, which is noticed under "Books" on this page. An appendix has been added describing and illustrating the several tools made by the above company for use in locomotive repair shops.

AIR BRAKES FOR ELECTRIC CARS.—The Westinghouse Companies' publishing department has reprinted an article on "Air Brakes For Electric Cars," which was presented by Mr. W. S. Bartholomew before the November, 1905, meeting of the New England Street Railway Association. The paper considers the advantages of this type of brake and describes the various types made by the Westinghouse Company.

PINTSCH GAS APPLIANCES.—A handsome 190 page standard 8¼ by 10¼ in. catalog, from the Safety Car Heating & Lighting Company, 160 Broadway, New York, illustrates and describes the various appliances used in connection with Pintsch gas. Several pages are devoted to hints on the selectiton of equipment. A sixteen page catalog, of the same size, describes the incandescent mantle lamps for Pintsch gas. With these mantles the candle power of Pintsch gas is increased more than three-fold and a satisfactory white light in produced.

WESTINGHOUSE TYPE SA MOTORS.—These motors and the controllers used in connection with them are described in circular No. 1117 issued by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. This new line of motors permits a speed range of 4 to 1 on a single voltage and is specially adapted for use in connection with machine tools. A complete description of these motors will be found on page 113 of our March issue.

NOTES.

STEAM TURBINES.—During the month of January, 1906, the Westinghouse Machine Company, East Pittsburg, Pa., entered orders for 22 steam turbines aggregating 56,500 brake horsepower in rated capacity, or an average of over 2,500 b.h.p. per turbine.

A LARGE ROOFING ORDER.—In rebuilding the factories of the Ohio Brass Company, Mansfield, Ohio, which were partially destroyed by fire last year, the order for roofing was placed with the H. W. Johns-Manville Company through their Cleveland branch. The roofing to be used is the well-known "J-M Asbestos Roofing," which is coming into very general use for large manufacturing establishments, railroad depots and large buildings. The order, which amounted to 850 squares, was placed with this company only after a most thorough investigation of the various prepared roofings now on the market.

QUINCY, MANCHESTER, SARGENT COMPANY.—This company has been incorporated and will take over the business heretofore operated by the Railway Appliances Company. This includes the business and plant of the Railway Appliances Company at Chicago Heights, Ill., formerly owned by the Q. and C. Company, also the business and plant of the Pedrick & Ayer Company, of Plainfield, N. J., manufacturers of locomotive repair tools, electric and pneumatic hoists, cranes, and pneumatic riveters. The Quincy, Manchester, Sargent Company will also act as the sole selling agent for the product of the Elastic Nut & Bolt Company of Milwaukee, Wis.

CHICAGO PNEUMATIC TOOL COMPANY.—This company has closed its Norfolk office and will in the near future open an office in Richmond, Va. The Pittsburgh office will, on April 1st, be moved to 10 Wood Street, at which point a store building has been secured for the purpose of making a general display of air compressors and pneumatic tools, a stock of which will be carried at this point as soon as the factories are in a position to furnish it. An up to date repair department will also be maintained at this point. The Seattle, Wash., office has been closed and a new office has been opened at 184 6th Street, North, Portland, Oregon.

THE BABCOCK & WILCOX COMPANY TRADE MARK.—A decree has been entered in the case of The Babcock & Wilcox Company against the Aultman & Taylor Machinery Company for infringement of trade mark in the United States Circuit Court for the Eastern Division of the Northern District of Ohio, in favor of The Babcock & Wilcox Company, in which the trade mark of The Babcock & Wilcox Company is sustained as good and valid. It consists of the word "Steam," accompanied by a representation of the type of engine known as the "Aeolipile of Hero," which consists in part of a sphere. The Aultman & Taylor Machinery Company are enjoined and restrained from directly or indirectly using, printing, publishing or putting into practice, or in any way counterfeiting or imitating said trade mark, or any like or similar thereto.

STANDARD ROLLER BEARING COMPANY.—The capital of the Standard Roller Bearing Company of Philadelphia, has been increased from $2,000,000 to $3,500,000. This increase is required to provide for an enlargement in their factory and equipment. A four story factory, 150 by 200 feet, will be erected immediately for the manufacture of annular ball bearings, on which this company holds basic patents. During the past year they have equipped with machinery a four story building, 95 by 200 feet, and have also built and equipped an iron foundry, 70 by 150 feet, two stories in height; a hardening and tempering building, 70 by 150 feet, and a crucible steel castings plant, 60 by 100 feet. With the new building the company will employ over 1000 hands, in the manufacture of steel balls, ball bearings, roller bearings, automobile axles and annular ball bearings.